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(54) Title: ORDER CHARGE SEPARATION AND ORDER–CHARGE TYPE SEPARATION

(57) Abstract

Apparatus or a device for producing order charge and/or order–charged matter, and/or a source of the same and/or apparatus and/or techniques for extracting the same. A device and/or apparatus for separating and/or concentrating and/or purifying the said order charge and/or order–charged matter, either collectively (e.g. mixture of charge types), and/or as partially and/or completely separated and/or purified individual charge types. Apparatus and/or a device for collecting and/or containing the order charge and/or order–charged matter. Apparatus and/or a device for outputting and/or applying the order charge and/or order–charged matter. A complete system of these apparatuses and devices together with input and output interfaces which produce, and/or separate, and/or capture, and/or store, and/or process, and/or treat the order charge and/or order–charged matter.

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ORDER CHARGE SEPARATION AND ORDER-CHARGE TYPE SEPARATION

This invention relates to the charges of the Ordering Force, to separating and/or concentrating and/or purifying these charges, either collectively and/or individually, and to all the technologies which can subsequently be developed to use these order charges.

There are two parts to scientific research, there is research and there is experience. That is to say, there is academic research, and there is an approach where you know that you have got the right answer because you get the result you sought. The latter is a more practical, more pragmatic, perhaps less intellectual, perhaps more intuitive approach where by processes of pure invention and continuous experiment, things can be achieved that cannot be achieved by the more rational academic approach.

The academic approach is well known. It involves theory and experiment. It involves making hypotheses and testing them. Sometimes, in this way, discoveries are made. But sometimes they are not, or at least they are rejected. Einstein once said that theory tells you what you can think. Therefore, if something is contrary to the theory, your mind may be tempted to reject it. There are well known examples of this in physics. Parity violation was first observed in 1928, but it was rejected as an aberrant experimental effect because the theory of that time said that parity violation was impossible. Then T D Lee and Yang suggested that parity violation might be possible and Mme Wu rediscovered parity violation a few months later in 1956. It was she who won the Nobel prize, not those experimenters in 1928. Other examples can be easily found. Indirect evidence for the 3°K blackbody radiation was first found by E. McKellar in 1941. Independently, T.A. Shmaonov observed the blackbody radiation directly and published the result in his thesis in 1957. However, neither of these researchers won the Nobel prize because they could not explain what they had observed. Finally Penzias and Wilson observed it again for the third time and then had the good luck to bump into Dicke at Princeton, who explained that this was the after glow of the big bang, the relic

radiation from Gamow's hot theory of the creation of the Univ rse. As a result, Gamow's theory was proven and Penzias and Wilson later won the Nobel prize.

My research has led me, over a forty year period, to conclude that there is a third long-range force in Nature, in addition to electromagnetism and gravitation, and I have found extensive evidence for this hidden away in the scientific literature. To my knowledge, few people or nobody expect this force to exist. My research shows that it creates order, that it reverses the second law of thermodynamics in animate and inanimate matter. So I call this force the "Ordering Force".

properties

The Ordering Force has peculiar properties. It has multiple charges M and it has multiple vector bosons N. It is a non-Abelian force so that the vector bosons, which for convenience may be called "Orderons", carry the order charge. As a result, the orderons are self-interacting. The orderons appear to be massless and so the force obeys an inverse-square law and is long-range. Therefore, the self-interacting orderons can form extensive networks.

The strength of the Ordering Force is about 6 times that of electromagnetism, depending on the energy, so that it is intermediate in strength between electromagnetism and the strong interaction. Present scientific technology cannot detect the order charge, nor can it detect orderons in the environment. Therefore, science is completely oblivious to the effects of this force. Nevertheless, its effects exist and sometimes these show up in scientific experiments, where they tend to remain as unexplained phenomena which are ignored. One of these strange effects is that the Ordering Force can transmute elements in both animate and inanimate matter. There are in fact hundreds of experiments which show this, yet they are little known, and either dismissed or ignored.

The way in which the Ordering Force can transmute elements is of interest, because it is unusual. There is evidence that it can transmute elements without producing any radioactive secondaries. In order to understand this, it is necessary to understand how it interacts with matter.

The Ordering Force does not interact with electrons, at least not directly, because it is not an electromagnetic force. Furthermore, it either does not interact with most nuclei which are order-neutral, or if it does interact with them, it does so indirectly. There are reasons to believe that most nuclei (on the earth) are "order-neutral", that they are not charged with the order charge. As a result, the orderons cannot interact with them directly. However, there may be order charge within

nuclei in which case they could interact with it by means of "order van der Waals forces", ie by distorting the order charge and then interacting with the dipole, quadrupole or higher moment. It would appear that the orderons can form networks around nuclei in order to so distort them and then interact with them. However, such order van der Waals forces would in the main fall off rapidly with distance (normal van der Waals forces decrease as $1/r^7$), and so they could well be quite weak, which is why their effects are not usually noticed.

The view that we have then, is that there is a third long-range force which currently cannot be detected directly and so is unknown to science. Most matter is neutral with respect to this force and interacts with it weakly or not at all, even though in principle it is stronger than electromagnetism. The experimental evidence is that this force can create order (ie reverse the second law of thermodynamics) and transmute elements without producing any significant amounts of radiation. It would appear that both these properties are related to the tendency of this force to produce extended networks of relatively strongly interacting orderons.

There is evidence that the orderons become distributed throughout matter and then interact sufficiently strongly with it that they cannot separate from it so that the orderon network cannot collapse. It appears that there is a dynamical balance between the orderon network and its interactions with the surrounding matter. It is this tension between the two which enables the network to continue to exist and which enables it to act upon matter to create macroscopic ordered patterns.

The information presented here concerning the Ordering Force simply has to be taken at face value. The actual experimental facts which support its existence, which determine its properties, and the relationship of this discovery to known physics, is to be published elsewhere. It is more of academic interest and does not in anyway change the picture presented above, although the names used could be different. For the purposes of identification, experiment shows that the number of charges M of the Ordering Force is not 1, nor 2, nor 4, nor 8, but appears to be 3. There would presumably be the same number of anti-charges. The order-neutral state would thus require three different order charges, or an order charge and its anti-charge.

The Ordering Force, as a new force, has many potential uses. Some of these, perhaps many of them, would require, or benefit from, the separation of the

order charges so that they subsequently may be controlled, processed, manipulated and so on in a wide range of possible technologies based upon this new force and related effects.

Order charges exist in Nature. They exist in at least two forms: either attached to matter or as orderons. When order charges are attached to matter, then in certain circumstances it would be possible to separate the order-charged matter from the order-neutral matter. The order-charged matter could then be collected, manipulated and processed in ways in which to use the order charges attached to that matter. All kinds of devices based upon these order charges could then be created from order-charged matter. The order charges could even be moved to other types of matter to facilitate its manipulation to create new types of materials and/or devices.

2 forms

In order to produce order charges, one needs a source. Order charges are produced in several ways with various degrees of impurity or purity. These charges may be used directly or further separated and purified. One process would be to separate the order-neutral matter from the order-charged matter. This could be done by an order-charge separator. The separated order charge could then be collected prior to use, or in certain circumstances, used directly.

Several examples will be given because the apparatus may take different forms. As order charge is separated and/or purified, it becomes possible to develop further devices and/or separators, and so examples of these will also be given.

An example of the apparatus and processes may be given in parts, firstly for the source, secondly for the separator, and thirdly for the collector. We will then show how these combine to produce a system. In addition there may need to be interfaces between the source and separator, and/or between the separator and the collector, and/or output system. The apparatus is shown schematically in figure 1.

A. There are various types of source of order charge. Order charge can be produced in nuclear processes but only under certain circumstances. The alpha decay of certain nuclei can produce order-charged alpha particles. Order charges may also be attached to neutrons, protons or pions emitted by nuclei. Order charges exist inside nuclei, and under certain circumstances are emitted naturally, or they can be deliberately forced out of a nucleus. If a radioactive nucleus is order-neutral, then it may still emit an order-charged secondary hadron, at least some of the time. Alternatively, a nucleus can be forced to emit order-charged fragments

by suitable processes, such as for example the collision of two nuclei in or as a consequence of a suitable accelerator device, or the collision of a particle with another hadron or nucleus, at suitable energies, usually above the threshold suitable to produce fragments some of which may be order-charged, typically being several tens of MeV per atomic mass unit or more.

More specific examples of these types of source are as follows:

1. A radioactive material which emits alpha-particles will produce some order-charged alpha-particles. This appears to be particularly the case for heavier nuclei, but any nucleus which emits order-charged alphas will do.

2. Certain rocks and crystalline materials contain radioactive inclusions, some of which can produce radioactive halos. These inclusions can produce alpha-particles or other radiation which carries the order charge. Such rocks and/or crystals could be processed, for example by cutting, and/or drilling, and/or pulverising, and/or grinding, and/or by some other method(s), and/or some combination of these, to extract the order-charged matter, for example by selecting order-rich regions.

3. A radioactive substance which emits some other kind of radiation, some of which may be order-charged.

4. A nuclear reactor produces alpha particles, some of which will carry the order charge. Some of the neutrons from a reactor may carry the order charge, as may some of the other particles from a reactor.

5. If a beam of nuclei is collided with target nuclei, or if a beam of elementary particles is collided with target nuclei, some of the fragments may be order-charged. Such interactions could be brought about with particle, nuclear, and/or heavy ion accelerator technology, and/or colliding beam technology. The fragments produced may or may not be mass and/or momentum and/or direction selected, and/or focused into a beam of fragments. Heavier nuclei may produce more order-charged fragments, but any nuclei which produce some order-charged fragments will do.

6. The sun is a source of order charge. The low fluxes of protons and alpha particles, and other particles, which come from the sun, are potential sources of order-charged matter.

7. The sun emits large numbers of orderons, which carry order charge, probably in the form of order-antiorder charge. However, orderons appear to be

massless and seem only to couple weakly to order-neutral matter, probably by order van der Waals forces. Never-the-less, matter that has been exposed to sunlight could contain order charge and could be used as a source if then processed suitably.

One or more of these sources of order-charged matter are then the source.

Separators

B. Secondly, there are various types of separator. Separators work on various principles which divide into two main classes. There are those which separate the order charges indirectly as a result of the changes they produce in the matter to which they are attached, and there are those which specifically act upon the order charge itself, for example via order-charge fields. The former are referred to below as "type-0 separators" or "type-0 spectrometers", or sometimes as primary separators. The latter, however may be considered to be secondary separators, because they require the existence of order charges and/or order fields to act upon the order charges to be separated. In other words, they will probably only be developed after order charges have been separated, probably by some other means, and/or order fields necessary for their function have been created. The latter are referred to below as "type-1, or "type-2/3, or "pure type-n (n = 1, 2, or 3), spectrometers".

Primary separators act upon the matter associated with the order charge and separate it from matter that is order neutral. Examples of methods for doing this are as follows:

1. An order-charged alpha particle or other order-charged matter will have a slightly different mass than that of the same order-neutral state of matter. Thus any device which separates matter into its different mass states could be used for the separation stage to separate order charges. For example, an order-charged alpha particle would have a mass approximately 0.1% to 1% different from an order-neutral alpha particle. A mass spectrometer could be used to separate these mass states, and the order-charged matter could then be collected.

2. There are numerous processes which are mass-sensitive or may otherwise be sensitive to order charge, such as various types of spectrometer, diffraction, resonance processes, kinematic processes, time of flight, range, diffusion, and even certain chemical reactions, which could be used to separate order-charged matter from order-neutral matter. Spectrometers with an electric and/or magnetic field together with some kind of velocity detector/selector and/or

time-of-flight device can separate different mass states.

3. Order charge probably changes other properties of matter. For example it may well alter nuclear magnetic moments, which could be selected by a resonance or other process.

4. Furthermore, order-charged matter may have different energy and/or directional properties at the source, and these could be selected upon to enhance the concentration of order-charged matter. This is particularly the case for order-charged fragments produced in nuclear collisions, but it might also apply to certain radioactive sources. By selecting upon those states which carry the order charge it might be more easily concentrated in certain circumstances. Furthermore, this selection at source could be combined with a suitable separator.

Secondary separators require the creation of order-charge fields, which then act directly on the order-charged states and deflect them so that they are separated and/or concentrated. Secondary separators are so called because, although they may later prove to be the most effective, they cannot be constructed until some way has been found of isolating order charge and/or creating order/charge fields, for example by first separating order charge with a primary separator. Once order charge can be concentrated, it would become possible to create a simple order-charge spectrometer. For example, a concentration of order-charge would deflect other order-charged states, but not order-neutral states.

Secondary separators

C. Thirdly, there are various possible types of output system and/or collector. The basic idea is that the system can either be run to supply order charge, for example to where it is directly required, or the order charge can be collected for subsequent distribution or use or application. The system could be built to act just as a source, or with a collector, or with both, which could be run alternatively, or even at the same time.

If the order charge is to be collected, then the type of collector depends upon the form of the order-charged matter, the type of separator used, and how much order charge one wishes to collect. The potential problem is that orderons can carry the order charge. Therefore, if too much order charge is accumulated in one place so as to create too high an order-charge potential, then it could simply be radiated away. In particular, the shape of gradient of order charge may be significant in determining the order field, so that by suitable control of the shape, the order field gradient can be limited and the risk and/or flux of discharge

minimized. If too high an order charge concentration is a problem, then the collector has to be changed, either continuously or discretely, so as to allow for the charge collected not exceeding a certain concentration. Or alternatively, the matter has to be arranged so that a radiated orderon is captured on another nucleus, thereby order-ionizing it, so that the total amount of order charge in the collector is conserved, or at least the leakage is minimized.

If the source is producing alpha particles or some other form of particulate matter, then those particles or nuclear fragments, could be trapped by a collector, either on a plate, or in a bottle, or concentrated in a bottle via a pump, such as a vacuum pump. If necessary they could be electrically neutralized, ie alpha particles could receive electrons and become helium atoms. If the particles are collected on a plate, this could be in the form of a moving strip, which would prevent the build-up of too much order charge. The strip could move to a place where it was processed to remove the order-charged matter, for example by heating, the order charge could be collected and the strip returned to collect more order charge from the separator, all as a continuous process.

It may be necessary for there to be interfaces between the source and separator and/or separator and collector. The first we call the input interface, and the latter we call the output interface. The input interface, if necessary, is designed to bring as many of the source order-charged matter into the separator, at the right energies, at the right angles, at the right state of ionization, and so on, as is possible for that separator. The output interface is designed to guide the maximum output into the collector, and/or maximize the purity being collected, and/or some other design consideration. The output interface may or may not have a decelerator, and/or a defocuser, and/or a stopper. In some cases these interfaces may just be simple mechanical connections.

An output system would deliver the order charge more directly to where it was to be used. This could take the form of a beam of order charge, or some system of applying order charge to materials, or some system of supplying order charge to other apparatus where it may or may not be collected, used or otherwise processed or some combination of these. If order charge is to be applied to materials, this could be done directly inside the vacuum of the system, where the order charge may or may not be controlled, positioned, focused and so on by suitable slits, optics, accelerations and/or decelerations.

Alternatively the order charge could be conducted out of the vacuum system of the apparatus and applied to materials external to the system. One way to do this would be to make a beam of order charge, which could be used for other purposes too. For example, a very thin window would allow order charge to pass out of the vacuum system, especially if the order charge was first accelerated to sufficient energy or already had sufficient energy to traverse the thin window. Once an external beam had been produced, it could be further manipulated with slits, optics, focusing and/or bending devices, other accelerating or decelerating devices, and/or other equipment, so that the beam can be given the required properties and directed to the appropriate place or places in a suitable or desired way.

Such output systems could supply order charge in a continuous or intermittent way, and could be used instead of a collector, or alternatively with a collector, or in parallel with a collector.

It is now possible to give several examples of the invention, now that the various pieces of the order-charge separation system have been presented:

I. The first example is as shown in figure 2. In this example, the source consists of heavy nuclei emitting alpha particles. This could be as a radioactive source, or it could be from a nuclear reactor. In the former case, the alpha particles will already be ionized, but in the latter case they may take the form of helium atoms and so have to be ionized. Helium atoms are not easily ionized and a plasma ion source or similarly powerful ionizing source would be required.

Alpha particles from a radioactive source typically have energies of millions of electron volts, and fragments from a heavy ion accelerator could be even more energetic. Mass spectrometers can be built to work at these energies, but large magnets are required. Mass spectrometers which are designed to work at lower energies can be just as precise and efficient, if not more so and usually cost less. Therefore, if there was a way to slow the alphas, or nuclear fragments, before putting them into the mass spectrometer, then this could be both cheaper and simpler. However, high voltage deceleration technology would be expensive and it would tend to produce an expansion of phase space, which would require (stochastic) cooling to get the flux up. One solution is to use the finite range to slow the alpha particles (or fragments but it will work best with mono-energetic alphas from a particular source) and pass them through a precisely designed foil or

metal plate specially shaped around the radioactive source, so that the alphas are almost stopped but emerge moving very slowly on the other side. A suitable high voltage accelerating and focusing field would then draw more of these alphas back into the mass spectrometer at the right energies. However, there will still be some spread in angles and kinetic energy, so that the mass spectrometer might have to be especially designed to handle the increased phase space. For this reason alternative types of spectrometer are considered below.

Electrically ionized alpha particles are then passed into a mass spectrometer, usually through a slit or system of slits, and often with suitable optics for guiding and focusing the flux. If the energies are thermal, or low, then they will have to be accelerated into the mass spectrometer. This could be done electrically as shown in the figure. The mass spectrometer has specially shaped electric and magnetic fields which guide the alpha particles along suitable trajectories, and separate them according to their mass. Usually the system is designed to focus the image of the inlet slit onto an outlet slit. In this case, the mass of the alpha particles which traverse the system can be selected by adjusting the position of the exit slit with respect to the image of the input slit. By adjusting the slit to allow order-charged alpha particles to be transmitted by the system, and order-neutral alphas to be blocked, it is possible to separate order-charged alpha particles from the order-neutral ones. The alpha particles are then passed through the output interface, if required, and stopped, and/or collected, and/or otherwise delivered to the output system. For example they can be stopped on a plate which also can neutralize them, and which may or may not be heated so as to boil them off into a vacuum pump which pumps the order-charged helium atoms into a suitable bottle to contain them.

There are two problems with this example concerning the source of the alpha particles and the resolution. If the alphas are slowed in a foil, then, depending on its thickness, they are either thermalized or still have higher kinetic energy. For example, the range of the 5.486 MeV alphas from Americium-241 is 22 microns of aluminium. A foil thicker than this will thermalize the alphas, a foil thinner than this will allow them to pass through with some residual kinetic energy. If the foil is thick enough to thermalize them, then they will have picked up atomic electrons and will have to be re-ionized by a plasma ion source or similar, becaus helium is difficult to ionize. If the foil is thinner so that they escape in flight, then

they will have a spread (possibly wide) in both angles and kinetic energies, which will result in reduced mass resolution for the spectrometer. Such a device measures the magnetic rigidity, which depends upon both the mass and the velocity, so that different mass and energy regions can overlap, thereby reducing the resolution.

The mass resolution actually required depends upon the mass difference between the mass of the normal alphas (αs) and the mass of the order-charged alphas-primes (α's), the relative fluxes of αs and α's, and upon the various backgrounds. If the spectrometer is sensitive to charge over mass (q/m) and one is working with singly charged alphas, then there are potentially two common backgrounds. The masses are:

Ion	Mass	A/q	delta	MeV
$^{4}He^{+}$	4.00207	4.00207	-	-
$^{12}C^{+++}$	11.99840	3.99947	-.00065	-2.4
$^{16}O^{++++}$	15.992787	3.99820	-.00097	-3.6

Thus there are two backgrounds on the low-mass side of the main (order-neutral) alpha peak. (There may be others depending upon the impurities in the vacuum.) There are several factors which determine the mass-resolution required for this system. Two of these are the mass of the order-charged alpha particle and the ratio of numbers of α' to α. If the mass of the α' is less than the mass of the alpha, then it can also be confused with these two backgrounds and higher resolution is required, than if its mass is greater than. If the α' mass is greater than the mass of the order-neutral alpha, then one does not need so much resolution to distinguish it from the backgrounds, but one still needs enough resolution to separate it from the tail of the main alpha peak. The ability to make this separation depends upon the difference in mass between the two types of alpha particle, and the relative numbers of αs and α's. If the relative flux of the latter is too low, then the few genuine events could be lost in the background tail of the main peak or other backgrounds. Higher resolution can help to resolve these problems.

Thus the first example given here would work provided that the various circumstances did not conspire to require a higher resolution and/or background rejection than can be provided by the combined effects of the source, the decelerating system, the input slits and optics, and the mass spectrometer. If however, higher resolution is required, then it would be necessary to go to some higher resolution kind of system.

II. One of the highest resolution systems is the Penning trap. The mass measurement of an ion in a Penning trap is made by determining its cyclotron frequency in a precision magnetic field. Resolving powers of one million or more can be achieved.

A typical system would consist of an alpha source (eg radioactive source or nuclear reactor with suitable plasma ionization, or heavy ion fragmentation source), with suitable degrader or thermalizer where required (eg a thin foil of suitable thickness for a given alpha source, or the degradation can take place in the radioactive source if it has a finite thickness. This can be fine-tuned by the simple method of rotating the alpha source, and/or foil if there is one, so that only alphas that have traversed some of the material of the source and/or foil could enter the spectrometer), plus an ion beam buncher and cooler, the Penning mass spectrometer, and some kind of detector and/or collecting system. The ion buncher and cooler could also be of the Penning trap type. It could cool the alpha particles by collisions with a buffer gas. However, there could be problems with the alphas picking up electrons and becoming neutral helium, since helium binds electrons very strongly, so that they could then not be trapped. One solution to this is to use an ionized buffer gas, but this could introduce other backgrounds. Or one could use another inert gas. The alphas are cooled and trapped in the first trap, and then sent by special optics to the second trap, where the mass measurement is made.

There are a number of potential problems with such a system:

a. Such a Penning trap has many parameters, typically about 100 to 200 or more, which have to be optimized. As a result such a precise instrument would take weeks to set up initially. Once set up, however, it might well run reliably, and so these set-up difficulties might be acceptable.

b. The trap measures the average mass of a number of alphas, so that if one has one α' with 9 order-neutral alphas in a bunch, then one would see the mass-shift as a significant proportion of the total mass difference. However, if there were more alphas in a bunch, say one thousand, then the shift in mass for one α' to 999 αs would be correspondingly smaller, and it might not be possible to detect the occasional α' at all easily. This would tend to reduce the useful bunch size.

c. Typically, the mass is determined in one of two ways. If there are enough ions in the trap, one can determine the cyclotron frequency from that of the

problems with detection

image charge. However, if there are fewer ions, then on has to eject them and determine the frequency with some kind of time-of-flight system or other detector. In the former case, it might be difficult to detect the odd α' amongst thousands of normal alphas, as in point (b) above, and in the latter case, one might be able to detect the occasional α', but there would still be problems actually separating that α' from the other more normal alphas because all the ions first have to go to the detector to determine whether or not such an α' is in the present bunch. Only after the bunch has arrived at the detector could the decision be taken to try to separate that bunch, which would normally be too late. There would then still be the problem of separating the α' from the others in the bunch. Small bunch sizes would also mean a small flux through the system. Of course, the system might be operated on individual alphas and α's, but then the flux would be very low.

d. In fact, whilst such a device might be used quite successfully to determine the mass of the α', there would be problems separating the α's from the normal alphas, because their trajectories are approximately the same since they are all in the same bunch. If there was some way of detecting the presence of an α', then it might be possible to eject that bunch along a different trajectory, no doubt more easily in the image current detection method, but then one would not have pure α's, but a mixture of order-charged and order-neutral alphas. If one was to feed the alphas through a chain of such and/or other separators, one might be able to produce a reasonably pure sample of order-charged alphas, but it seems unlikely that such a system would be particularly satisfactory from a number of points of view including cost, efficiency and ease of setting-up and operation.

III. What one needs is a type of spectrometer in which the separation takes place more cleanly. One possibility might be a time-of-flight spectrometer. If one has a monochromatic source of alphas, such as americium-241, and the alphas are guided through the vacuum system of the spectrometer (without degrading their energy, as with a foil), then one still has to allow for background alphas from the source which do not have the same energy as the main peak. One way to do this is with a combination of magnetic spectrometer and time-of-flight. But time-of-flight requires start and stop signals. X-rays from the source might provide the start signal, but this would be an unusual technology and it is not clear how precise the time resolution would be. Furthermore, the stop signal would also come from a detector in the vacuum system which would absorb the alpha. This

might be good enough to measure the mass of the α', but it would require some ingenuity to separate order-charged from order-neutral alphas and to collect them. Some of these problems could be eliminated by accelerating the alphas to several GeV and using the techniques of high energy physics.

IV. So what one needs is a high resolution spectrometer, which may have two separate separation processes, which causes the order-charged alphas to be physically separated from the order-neutral alphas, in such a way that they can be directed towards a suitable collection device. In this way, despite the different incident angles and energies of the alphas, the order-charged mass state can be cleanly separated from the normal mass-state and from any backgrounds present in the system, and then directed to a collector where the order-charged alphas can be collected for later removal from the system and storage, or whatever use is required.

One such spectrometer which allows for such precise separation is the Smith spectrometer. The Smith-type mass-spectrometer makes use of a combined system of magnetic fields, slits, other optics, and a radio-frequency system, to separate different mass and energy states.[1] The system can be designed and tuned to operate over a range of masses and of mass-resolutions up to a resolution of 10^5 or more.

Figure 3 shows the principle of operation of a Smith-type spectrometer. The beam of ionized alphas is injected into the system through a system of suitable deceleration, acceleration, optics and slits. Once inside the spectrometer, the beam of alphas orbits with a radius of R=SQRT(2mT)/qB, where m is the mass of the ion, q its charge, T its kinetic energy and B the magnetic field in the spectrometer. Thus different mass and kinetic energy states can have the same radius of orbit. These can be further separated by means of their cyclotron frequency.

The cyclotron frequency of such a particle is given by $f_c = qB/m$. If there are two particles 1 and 2 with masses m_1 and m_2, then they are linked by the relationship: $m_1 f_1 = m_2 f_2$. An RF signal is applied to the RF modulator in such a way that the beam is accelerated by a certain amount on the first crossing, and decelerated by an equal amount on the second crossing, so that the net energy gain is zero. One thus has two mass resolution effects, one which depends upon kinetic energy and the other which does not. This enables one to determine the mass

[1] L.G. Smith, *Phys. Rev.* *C* 4, 22-31 (1971), and references therein.

independent of the spread of kinetic nergy and angles at the input. Typically th RF frequency is run at $f = (n + 1/2) \times f_c$, where n is an integer, and the resolving power is given by $2\pi n(d_m/w)$ where w is the common width of the inlet, modulator and exit slits, and d_m is the modulation amplitude of the diameter. If the RF frequency is scanned, one gets peaks corresponding to the different mass states.

The beauty of such a device is that it can be designed to optimize the separation of order-charged alphas from order-neutral and/or other backgrounds, despite a spread in input angles and kinetic energies, to optimize the transmission of the system so as to trap α' efficiently, and it runs in a continuous mode, so that one can pass ~~a steady~~ stream of alphas and α's into the system, and separate out cleanly a beam of α's which can be guided to a suitable collector.

The Smith spectrometer can of course be used with other types of matter, other than alphas, in order to separate order-charged states from order-neutral states.

A Smith-type spectrometer can be designed to be used with different types of source, such as an alpha source, a heavy-ion accelerator source of alphas of other types of matter and/or nuclear fragments, a reactor, or other alpha or helium source, or even commercially available helium gas, or other sources of order-carrying matter. The source is likely to be chosen for reasons of cost. Typically one would want the highest flux of order-charged matter through the system for the least cost. If a radioactive alpha source is used, then one is likely to have to have a foil to slow the alphas down, or to turn the source at an angle so that the alphas are degraded in the material of the source. Or one could thermalize the alphas, but then they would have to be re-ionized by a suitable plasma or other ion source. Alphas from a heavy-ion source, from a reactor or from another source or helium gas source would have to be first ionized by a suitable plasma or other ion source. Other states of matter from a heavy-ion source would require to be ionized if previously they had been thermalized.

It is straightforward to connect a plasma ion source and feed helium gas into the system. Other sources of order-charged matter such as heavy ion sources, nuclear fragments, or other source of order-charged matter or radiation of any kind could be used. If the system is to be used with several input sources, then it would be convenient to have a switch-yard to facilitate change from one source to another.

These slowed-down ionized alphas or ther states of matter would then be focused and accelerated into the Smith-type spectrometer using suitable combinations of acceleration technology (high voltages) slits and focusing devices. All would have to be in a vacuum because alphas or other states of matter have such a short range. Once a beam of order-carrying states had been formed, it would be guided into the Smith spectrometer, where the mass separation processes could be adjusted to separate out order-charged mass states, as already explained, so that they could be guided to a suitable deceleration and/or collection system, or alternatively used as a source of order-charged matter which could be applied to materials within the vacuum system, and/or turned into a beam of order-charged matter, and/or passed into further stages of acceleration, and/or passed through a thin window so as to form an external source and/or beam, and or used in a treatment plant and/or directly as a source of order charge.

We refer to these examples (I to IV), which separate order-charge from order-neutral states, (but without further separation of the order-charge states, eg because they do not deploy order-charge in the active separator) as "type-0 spectrometers" or "type-0 separators".

A Smith-type spectrometer or another other type of spectrometer or separator used in order-charge separators, are normally designed to achieve a given mass resolution. When one is used as of an order-charge separation system, then the purity of the separated sample, and the flux through the system are more important considerations, although they may depend upon the mass resolution, possibly in conflicting ways. One solution to this would be to design the system with variable resolution and/or other variable parameters, so that it can be run in different modes, for example to maximise purity or to maximize the yield, or some combination of these and/or other factors. One way to do this would be with variable slits. If the various slits and/or apertures in the system are driven by electric motors or other means, then they could be adjusted to provide the performance or mode required.

V. Once order charge has been separated, it becomes possible to build an order-charge spectrometer which uses previously-separated order charge, or an order field, to separate order-charge from other matter, and further separate order-charge types. Figure 5 shows a schematic of an order-charge spectrometer, or secondary spectrometer, as we call it. (Different forms of this are referred to below

as "type-1 spectrometers", "type-2/3 spectrometers", and "pure typ -n spectrometers" where n = 1, 2, or 3.) In this order-charge spectrometer, a suitably-shaped amount of order charge is used to deflect order-charged states, from order neutral states. Order-neutral states do not sense the field, unless it is via short-range order van der Waals forces, and so passes (almost) straight through the apparatus. On the other hand, order-charged states sense the field of the order charge and are deflected. These deflected states can then be separated from the order-neutral states by systems of slits and/or barriers, or other separators, and then collected, stored, or otherwise used in subsequent stages and/or elsewhere. Note that the range of the order force is only known to extend to microns, at present. If the range of this force is found to be long-range, ie extending to infinity, then one could design a large scale separating device. However, if the range is limited in some way, then some small-scale precision engineering would be required.

There are two types of deflection in the order-charge field: like charges are repulsed, and different charges are attracted. There are three different types of order charge, which we can call type-1, type-2 and type-3 for convenience. (Red, green and blue are alternative names for these three charges.) If one type is repulsed, then the other two types will be attracted, and so the repulsed charges will always be purer than the attracted charges. This then provides a mechanism for separating order-charge states into their subsequent three charge states.

Firstly one has to separate some order charge with a primary spectrometer. One can then use this separated charge to construct a secondary spectrometer. The distribution of charge types (type-1, -2 or -3; red, green or blue) of the three charge states, will probably be random, and will therefore be roughly equal amounts of each different charge-type. However, it is unlikely that there will be exactly equal amounts of charge, and there will always tend to be one charge-type which predominates. This is especially true for small order-charge samples. Thus, one can separate the same charge state by using the repulsed order-charge, and one can concentrate it with a cascade of order-charge spectrometers. Alternatively, it can be concentrated by collecting the repulsed state, and then using that to make the next order-charge pole, which can then be put back into the original order-charge spectrometer, or used as the pole of the second order-charge spectrometer. Alternatively, one can repeatedly pass it through one spectrometer, taking the

How to separate order charge states

repulsed fraction each time, to purify it. Charge that is progressively repulsed by a chain of such spectrometers, or by repeated separation, will become progressively purer in that one charge state.

Likewise, the attracted states will become repeatedly pure in the other two charges. One can then make a tertiary spectrometer using these other two charges as the spectrometer pole, and then repeatedly passing the two charge states (ie attracted from the secondary spectrometers) through and collecting the repulsed state. Repeatedly doing this, either through the same spectrometer, or through a cascade of spectrometers, or by using the output to create the pole of the next spectrometer, and so on (eg in a similar way used to separate type-1 charge), will further enhance the separation of the remaining two charges.

VI. Once these three charge states have been separated, then it would start to become possible to set up a complete system to separate the three charge states. That is to say, there is a sequence of step which has to be followed: firstly, one separates and concentrates order-charge states from order-neutral states. Then one uses the separated charges, especially fluctuations in the same, to separate the individual charge states. Once pure samples of the individual charges states have been separated, then it would be possible to set up a production system to separate each of the three charge states.

Figure 6 shows an example of a complete order-charge separation system right down to the individual charges. (The same comments about the dimensions of figure 5 apply here.) It requires the pre-existent separation of two order charges (say type 1 and type 2) and their fabrication into the active elements of two pure-order-charge spectrometers in tandem (in the figure these are pure type-1 and pure type-2 spectrometers, although any permutation of the charge types is possible). Then the first spectrometer (type 1) will repulse type 1 charge and separate it, whilst order-neutral states will pass right through. Subsequently, the second spectrometer (type 2) repulses type-2 charges and separates them from type-3. A subsequent (third) type-3 separator can be used to effectuate further purification of the type-3 charge. If the three final charge states are not pure enough, then a cascade of such devices will produce purer charge, or it can be recycled for further purification.

VII. What one sees is that as the technology is worked with and as order charge is separated in ever purer samples, it becomes possible to design more

precise and ffective separation systems. The first level of this invention involves the separation of raw order charge (or mixed charge-types); the second in splitting this charge into ever purer samples of the three charge types; at which point it becomes much easier to separate order-charge and non-order-charge states and to split the three order-charge types directly.

CLAIMS

1. An order charge separation apparatus comprising a source, with or without suitable modifications to enhance the flux and/or concentration of order charge, with/or without ionization equipment, with/or without suitable interface, an order-charge separator if required, with/or without suitable output interface, and/or with a suitable output system, and/or a suitable collector if required, single, series, multiples and/or cascade arrangements of similar and/or different devices, separating, and/or collecting, and/or output devices, all with suitable vacuum systems, optics, and/or slits and/or baffles, and/or supporting equipment.

2. An order charge separation apparatus as claimed in 1, wherein the source is a source of ionizing radiation, such as an alpha emitter, which carries the order charge on at least some of the particles of radiation.

3. An order charge separation apparatus as claimed in 1, wherein the source is some form of matter, some or all of which carries the order charge such as helium from a reactor, and/or order-charged states which have previously been through some stage or stages of separation, and/or purification, and/or concentration, which may or may not be ionized electrically.

4. An order charge separation apparatus as claimed in 1, wherein the source is some kind of radiation device, such as a nuclear reactor or accelerator, in which the device produces order-charged matter either continuously or in bursts, or some combination, either partially or totally ionized or non-ionized, which then may or may not have to be separated or concentrated, or otherwise processed either continuously or in batches, so as to produce a supply of order-charged matter which can then be fed to or supplied to the source of the order-charge separation apparatus as its source of order-charged matter.

5. An order charge separation apparatus as claimed in 1, wherein the source is some kind of radioactive halo and/or rock and/or crystal and/or material there from, and/or other material substance which contains order charge, which may/or may not have to be first processed to carry out some kind of preliminary order-charge concentration either on the basis of the region of origin of the matter, and/or the particular properties of the matter which is known to carry the order charge, and/or on some other basis.

6. An order charge separation apparatus as claimed in 1, wherein the source is some kind of particle accelerator, nuclear or heavy ion accelerator and/or storage ring and/or colliding beam machine, which by processes of suitable interactions causes nuclei to fragment into fragments, some or all of which are order-charged. These interactions could be brought about by a beam of nuclei being made to collide with target nuclei, or by a beam or source of elementary particles or other matter or radiation being made to collide with target nuclei or vice versa, so that some order-charged fragments or radiation are produced. Heavier nuclei may produce more order-charged fragments, but any nuclei which produce some order-charged fragments will do. This may or may not include further apparatus. For example, the fragments produced may or may not be mass and/or momentum and/or direction selected, and /or cooled, and/or decelerated, and/or accelerated, and/or focused into a beam of fragments, and/or ionized.

7. An order charge separation apparatus as claimed in 1, wherein the source consists of free order charge which has subsequently been attached to matter. Orderons are order-charged or at least order-antiorder charged, and for example come from the sun, so that exposure of matter to sunlight in some way will result in it being permeated with some form of order charge. If the matter was originally order-neutral, then it will become filled with orderons carrying the order charge, but not actually directly attached to the nuclei, although they could be attached indirectly, for example by order van der Waals forces. Such matter exposed to orderons might or would then be a source of order charge, albeit after further processing to put the matter in a state suitable for separation and/or collection.

8. An order charge separation apparatus as claimed in 1 and 2, wherein the radiation has been passed through the input interface if necessary, and been separated, collected and/or concentrated in someway to concentrate or enhance the flux, and/or wherein the radiation has been ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated or degraded, and/or accelerated, and/or some combination of these.

9. An order charge separation apparatus as claimed in 1 and 3, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

10. An order charge separation apparatus as claimed in 1 and 4, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

11. An order charge separation apparatus as claimed in 1 and 5, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

12. An order charge separation apparatus as claimed in 1 and 6, wherein the fragments are passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

13. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and/or 12, or combination thereof, wherein there is one or more

sources of order charge which may be used in various ways including one at a time, sequentially, alternatively, and/or simultaneously.

14. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and/or 13, or combination thereof, wherein there is switch-yard to facilitate switching from one source to another, if required.

15. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and/or 14, or combination thereof, wherein the partially or completely order-charged matter is suitably prepared for separation and/or collection.

16. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and/or 15, or combination thereof, wherein the partially or completely order-charged matter is introduced into the separator, and/or collector.

17. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and/or 16, or combination thereof, wherein the partially or completely order-charged matter is passed through a separator so as to separate, partially or completely, order-charge from order-neutral states, and/or otherwise concentrate order-charge and/or order-charged states.

18. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein the separator is a mass spectrometer or mass-spectrometer type of apparatus, and/or accelerator-type of mass-spectrometer, and/or accelerator, and/or cyclotron or similar device, and/or storage ring, and/or Penning trap and/or Smith-type spectrometer, or some combination of same, in which combinations of electric and/or magnetic fields and/or time-of-flight, and/or slits, and/or other methods, separate different mass states corresponding to different order-charge states.

19. An rder charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and/or 17, or combination thereof, wherein the separator is based upon range, so that a precisely determined amount of matter is used to separate and/or concentrate order-charge and/or order-charged states at the expense of order-neutral states.

20. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and/or 17, or combination thereof, wherein the separator is a combination of range and a mass spectrometer (eg as specified in 19 and 18 respectively), so that partial separation is brought about by range, and then further separation is brought about by using a mass spectrometer, or vice versa, or by some other method. Alternatively, range attenuation may be used as part of the input interface to reduce the energy of the input particles either to those that match the mass spectrometer, or to even lower energies, cool and/or thermalize them, as part of an input interface which subsequently accelerates and/or focuses the order-charged states so as to match their input energy and phase space of the mass spectrometer and maximize the flux through it if so desired.

21. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein the separator is some other type of spectrometer with an electric and/or magnetic field together with some kind of velocity detector/selector and/or time-of-flight device and/or energy loss device, which can separate different mass states.

22. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein the separator is on one or more other types of process which may be mass-sensitive, or may be sensitive to nuclear magnetic moments, or may otherwise be sensitive to order charge directly or indirectly, such as various types of spectrometer, diffraction, resonance processes, kinematic processes, range, diffusion, and even certain chemical reactions, which could be used to separate order-charged matter from order-neutral matter.

23. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein the separator is an order-charge separator where the active element is order-charge itself, either previously separated or otherwise obtained, and/or an order-charge field, so that order-charge states passing through this order-charge spectrometer tend to be deflected by the order-charge and/or order field, whilst order-neutral states are not so deflected and so continue in their normal trajectory. (Such an order-charge separator may be referred to as a secondary separator, although once built it may be used as a primary separator.) Some order-charge will be repulsed by the separator, other charge will be attracted by it. The former is like charge, the latter are the different charges. The former tends to be purer in the sense that it is one charge state, whereas the latter tends to contain two charge states, depending how pure the separator charge and/or field is.

24. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and/or 23, or combination thereof, wherein some kind of restriction(s), limitation(s), cut(s), slit(s) and/or aperture(s), and/or optics, or other type of separation(s), either physically, logically, and/or both, or some combinations of these, is/are introduced to separate and/or concentrate order-charge states from order-neutral states, which could be made at one or more or various places in the system as required.

25. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23 and/or 24, or combination thereof, wherein some kind of fixed, and/or moveable, and/or variable slit(s) and/or aperture(s) and/or barrier(s) is/are used to separate order-charged states from order-neutral states. In particular, if there is a mass spectrometer, the mass, order-charge and/or other type of spectrometer which may or may not be equipped with some kind of entrance aperture, and may or may not be equipped with some kind of exit aperture and/or other apertures positioned in such a way as to separate order-charged states from order-neutral states. The exit slit(s) or aperture(s) may or may

not be positioned at the exit focus, and may or may not be an image of the entrance slit(s) or aperture(s). By adjusting the slit(s), and/or aperture(s), and/or barrier(s), and/or frequency(ies), and/or magnetic field, and/or optics, and/or timing, and/or kinematic limits, and/or any other parameters, qualities, aspects cuts, and/or conditions of the system, it may or may not be optimized for maximum resolution, and it may or may not be optimized for maximum flux or yield through the apparatus, and/or it may or may not be optimized in some other way, or some combination of these.

26. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19 and/or 20, or combination thereof, wherein the thickness of material traversed is sufficient to partially and/or completely separate order-charge from order-neutral states. The range separation may be supplemented by some other method. This technique may be part of the input interface to the subsequent method of separation.

27. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 and/or 26, or combination thereof, wherein some kind active and/or triggered device is engaged to separate one or a small group of order-charged particles and/or states from order-neutral states. Such a device might be a mobile shutter, or a pulsed field, electric or magnetic and/or both, or a kicker magnet, or some other mechanical and/or electronic and/or order-charged device, and/or time-of-flight system, and/or pulse height technique, and/or energy loss system.

28. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26 and/or 27, or combination thereof, wherein selecting upon those states which carry the order charge it might be concentrated in certain circumstances. In particular, order-charged matter may have different energy and/or directional properties at the source, and these could be selected upon to enhance the concentration of ord r-charged matter. This is particularly the case for order-charged fragments produced in nuclear collisions where some kind of

direction and/or velocity, and/or momentum, and/or particle-type, and/or other selection(s) would enhance the order charge flux and/or composition, and/or purity, but it might also apply to certain radioactive sources. Furthermore, this selection at source which might achieve sufficient purity under certain conditions, but if necessary it is also be combined with a suitable separator.

29. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 and/or 28, or combination thereof, wherein there is some kind of output interface if necessary, and/or output system (eg to act as a source), and/or some kind of collector to collect the order charge.

30. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28 and/or 29, or combination thereof, wherein the output interface, if necessary, and/or output system, and/or the collector is/are some kind of stopping device and/or container, suitably shaped, if necessary, to collect the order charge and/or if necessary minimize the discharge of order charge.

31. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 and/or 30, or combination thereof, wherein the collector is designed to trap and if necessary stop the order-charged matter, and/or order charge, and/or other matter, as it leaves the source and/or separator. The collector can be a container, suitably shaped if necessary, attached to the source and/or separator, or separate from it if necessary, or even a hopper, depending upon the type of material to be collected.

32. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30 and/or 31, or combination thereof, wherein the output of the source and/or separator is in a vacuum or semi-vacuum and is moving, and this output passes through any valves and/or diaphragms and/or apertures

as necessary, into the stopper and/or collector, so that the output is slowed and/or stopped, and then either contained, and/or extracted from the vacuum.

33. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and/or 32, or combination thereof, wherein the stopper is a Faraday cup, and/or metal plate, and/or other material, solid, liquid or gaseous (provided that it does not spoil the vacuum too much, for example it might be in a containing material or materials), which stops and may or may not absorb the order-charged materials. If the stopper absorbs the order-charged materials, then there is a way or ways of extracting the order-charged materials and/or order charge either on-line or off-line, either continuously or in steps. For example, the metal plate could simply be removed after absorbing the order-charged material for a certain time, and the order charge used and/or extracted off-line. Or this could be a stage in the manufacture of the stopping material. Or if there is fluid in the stopper, then this fluid could be extracted and/or circulated either continuously or after a certain amount of time, taking most of the order charge with it for subsequent separation. Or the stopper could be made to re-emit the order charged matter, either continuously or in stages, for example by heating, so that it could then be collected in a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge. Or if the stopper is moveable, either discretely and/or as a continuous strip, then it could be first moved to a separate area in the vacuum chamber which could be partially or even completely protected from the rest of the vacuum system, where the stopper or a portion of the stopper could be made to re-emit the order charged matter, either continuously or in stages, for example by heating, so that it could then be collected in a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge.

34. An rder charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32 and/or 33, or combination thereof, wherein the stopper is a decelerating device, which may or may not be suitably shaped electric and/or electromagnetic fields, which slows or otherwise stops the output from the separator, so that it could then be collected in a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge.

35. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33 and/or 34, or combination thereof, wherein the container with the separated and/or purified order charge can be separated from the rest of the apparatus and then taken away for use elsewhere. This can be done in such a way that the source and/or separator can be operated continuously or in a batch mode.

36. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34 and/or 35, or combination thereof, wherein the order charge is deposited, stopped in, or otherwise applied to materials, components, and/or devices, which are subsequently going to be used in that or some other order-charged state. The order charge could be deposited in one region, or it could be applied over an extended region or several regions and/or spots, either by moving the beam of order-charged and/or by moving the material, component, and/or device. This could be as part of their manufacturing process. This could be done in batch mode, or a few at a time. Or it could be done partially or completely continuously, with the materials, components, and/or devices being introduced into the order beam either singly or in groups, either a few at a time or as part of an assembly-line system with more continuous flow, possibly with suitable materials handling devices.

37. An order charg separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 and/or 36, or combination thereof, wherein alternatively to, or in addition to the collector system, there is some kind of output system. The output system could provide an order-charge source, and/or order-charge beam, and/or be part of an order-charge treatment plant. It could be used to supply order-charge directly to where it is needed, or to be used, and/or it could provide a beam of order charge. In the latter case, the beam could be either internal, or external. For an external beam, a thin window would allow order-charged matter to exit the system as a beam. The range would not be far in air, but this might be sufficient for whatever usage was required. Whatever the output system and/or collector, further optics and/or acceleration and/or deceleration could be part of the output system.

38. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 and/or 37, or combination thereof, wherein there is a detector(s), or detector system, which is/are in or can be placed or inserted in the output (separated) beam, and/or to which that beam can be directed, and/or by some other mechanism. The system is operated in such a way as to separate order-charge states from order-neutral states. (We refer to such separation systems, and sequences of such systems, as "type-0 spectrometers" for convenience of reference.) This would normally require precise measurements of the mass(es) of the order-charge states, for which the detector would be necessary. Once this or these have been obtained, the apparatus can then be tuned to select that particular state that carries the required order charge. The detector would facilitate this tuning. With careful design, the apparatus can be arranged and/or adjusted so as to select the required order-charge state as cleanly as possible and/or to maximise the through-put and hence the efficiency. The detector would also facilitate these adjustments. It could even be used to monitor performance, for example by switching it in and out of the beam as required.

39. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37 and/or 38, or combination thereof, wherein one or more of these processes can be applied sequentially and/or in combinations.

40. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38 and/or 39, or combination thereof, wherein order charge having been separated it is subsequently used to generate suitable order fields which then subsequently separate further the order-charged states from the order-neutral states, and/or from each other (ie to separate the three order charges). This could be a type of order spectrometer, for example in which order charge and/or order fields is/are the active element(s). Previously separated order charge could be suitably shaped and used either as the deflecting mechanism in an order charge spectrometer, or it could be combined with suitably shaped electric and magnetic fields to improve the optics and/or separating efficiency and/or flux and/or yields. Such an order spectrometer would have a suitable source(s), suitable input interface(s) if required, suitable output interface(s) if required, suitable output system(s) and/or suitable collector(s), and/or suitable optics, slits baffles, selecting systems, vacua and supporting equipment.

41. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39 and/or 40, or combination thereof, wherein the separation process is brought about by previously separated order charge, or by an order field, which is then used to separate order-charge from order-neutral states, and/or to further separate and/or purify order charge, for example by repeated passes, and/or repeatedly upgrading the deflecting order charge in the spectrometer, and/or by means of a series of spectrometers and/or devices. When order charge passes near to order charge, the two charges will be attracted or repelled from each other according as to whether they are different or like charges. Because

there are three types of order charge, depending upon the composition f the deflecting order-charge in the spectrometer, one sort of charge will be repelled (the like charge) and the other two charges (the different charges) will be attracted. As a result, the repelled charge will tend to be the purer order-charge state. Order charge that has been separated from order-neutral states, will not initially be in one of the three order-charge states, but will tend to be a random collection of the three order charges. As a result, the numbers of different types of order charge will vary and one type will be dominant, however slightly. (Furthermore, statistical fluctuations will tend to be larger in small samples rather than large samples. So there is a trade-off between using smaller samples of charge, where the dominant charge-type is more clearly defined but the force exerted on the order-charges to be separated is less, and larger samples of order-charge where the dominant charge-type is less well-defined but the force exerted on charges to be separated is greater. The system has to be designed and tuned so that one starts to separate, even if only statistically, on a particular order-charge type.) If the three types of order charge are passed by an order-charge spectrometer which uses this mixed order charge as its active separating element, then the repulsed charge, especially the more strongly repulsed charge, will be the like charge of the dominant charge. Therefore by selecting on the repulsed charged, it is possible to create a sample of a particular type of order charge (say type 1) or at least a more pure sample than was in the incident beam.

42. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40 and/or 41, or combination thereof, wherein the repulsed order charge is used to effect further separation, either by being collected and formed into a pole for the primary order-charge spectrometer that has just selected it (as in 41) and then used to replace that pole (and so form its active element), and/or is used to form the active element(s) of another and/or separate order-charge spectrometer(s), or in some other way.

43. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41 and/or 42, or combination thereof, wherein the repulsed order charge is used repeatedly to form a new pole (ie active element) of primary order-charge separator, and/or used to form poles of secondary, tertiary and/or cascades of subsequent order-charge separators, so that the repulsed order charge is passed through the system, and the repulsed order charge is selected at each stage, and then either used to form the active element of the next (and/or repeated) stage and/or then passed through that subsequent stage and the repulsed order-charge again selected, so that ultimately a pure sample of a particular type (say type-1) of order charge is obtained. (We refer to such separation systems, and sequences of such systems, as "type-1 spectrometers" for convenience of reference.)

44. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42 and/or 43, or combination thereof, wherein the purified order charge (say type 1) is used to form the active element of an order-charge spectrometer, which for convenience we refer to as a "pure type-1 spectrometer". This device can then be used to separate type 1 charge, which is repulsed, from types 2 and 3 charges which are attracted. A sample of types two and three charges are selected and used as the active element of an order charge spectrometer, and types two and three order can start to be separated by a process of amplifying a statistical fluctuation as the type-1 charge was separated. The repulsed charge is selected and then use to form the pole of such a type-2/3 spectrometer, so that further separation of type 2 charge from type 3 can be effected. This could then take place in repeated sequences, or series or cascades of such order charge spectrometers, similar to the way type 1 charge was separated. (We refer to such separation systems, and sequences of such systems, as "type-2/3 spectrometers" for convenience of reference.) In this way, pure type-2 (say) order charge can be s parated.

45. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43 and/or 44, or combination thereof, wherein the purified order charge (say type 2) is used to form the active element of an order-charge spectrometer, which we refer to as a "pure type-2 spectrometer". A pure type-2 spectrometer can then be used to separate type-2 charge (the repelled fraction) from type-3 charge (the attracted fraction).

46. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44 and/or 45, or combination thereof, wherein the purified order charge (type 3) is used to form the active element of an order-charge spectrometer, which we refer to as a "type-3 spectrometer". A type-3 spectrometer can then be used to separate type-3 charge (the repelled fraction) from any other backgrounds, if it found that the type-3 charge from the pure type-2 spectrometer is not pure enough. Once a pure enough sample of type-3 charge has been produced, it is then possible to construct a "pure type-3 spectrometer".

47. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 and/or 46, or combination thereof, wherein the various different types of spectrometer are combined together to separate the three order-charge types. The simplest arrangement of these is two pure spectrometers for two different charge types (eg type-1 and type-2 or type-3, type-2 and type-3) in either order, which can then be arranged to separate order-charge from order-neutral matter, and to separate the order charge into each of its charge types. For example a pure type-1 spectrometer will repulse order-charge of type-1, allow order-neutral states to pass straight through, and attract order charges of types -2 and -3 into the second spectrometer, which if it is of the type-2 will repulse type-2 order charge and attract type-3 order charge. A

spectrometer of the third type could be added if further separation of the latter attracted fraction is required. A suitable system of optics, and/or slits, and/or baffles, and/or barriers, is/are used in combination or separately to effect the various separations. The system also has a suitable source(s), vacua, interfaces if required, and/or output systems if required, and/or collectors if required, and/or some combination thereof as required.

48. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46 and/or 47, or combination thereof, wherein the various sources, devices, components, systems, spectrometers, collectors and/or outputs are combined together in such ways as produce the order charge states, whether combined or separate, with the purities and/or in the quantities required.

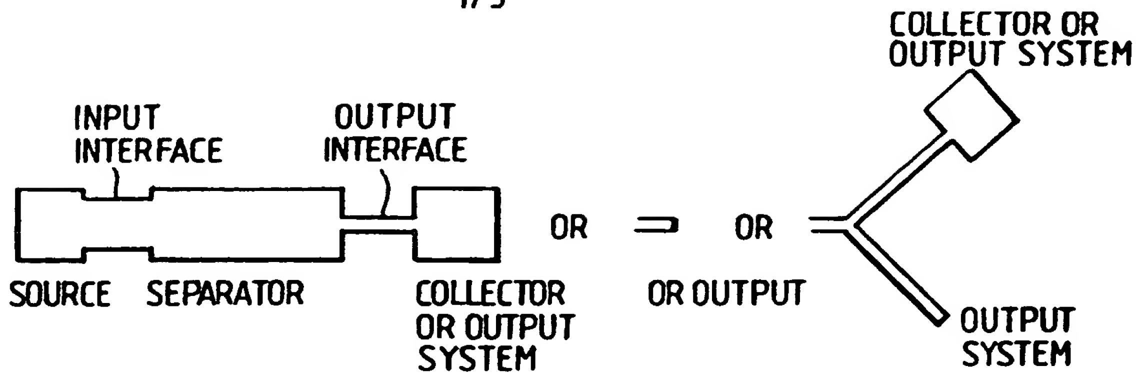

COLLECTOR OR
OUTPUT SYSTEM
INPUT
INTERFACE
OUTPUT
INTERFACE
OR
OR
SOURCE
SEPARATOR
COLLECTOR
OR OUTPUT
SYSTEM
OR OUTPUT
OUTPUT
SYSTEM

Fig.1.

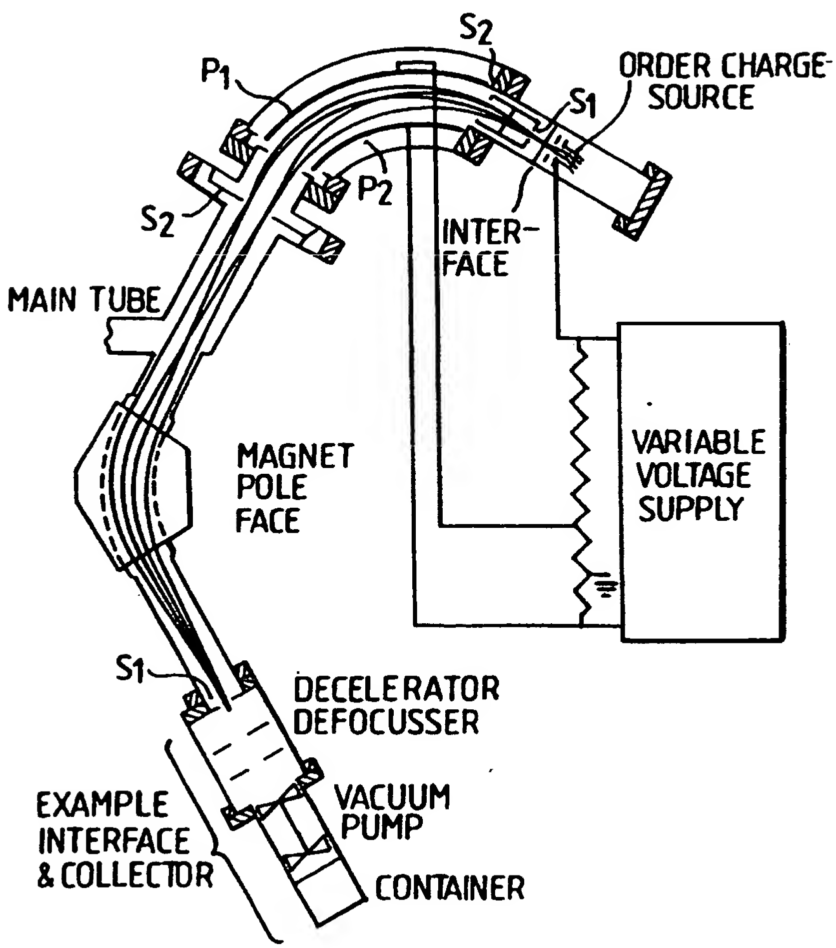

S2
P1
ORDER CHARGE
SOURCE
S1
P2
S2
INTER-
FACE
MAIN TUBE
MAGNET
POLE
FACE
VARIABLE
VOLTAGE
SUPPLY
S1
DECELERATOR
DEFOCUSSER
EXAMPLE
INTERFACE
& COLLECTOR
VACUUM
PUMP
CONTAINER

Fig.2.

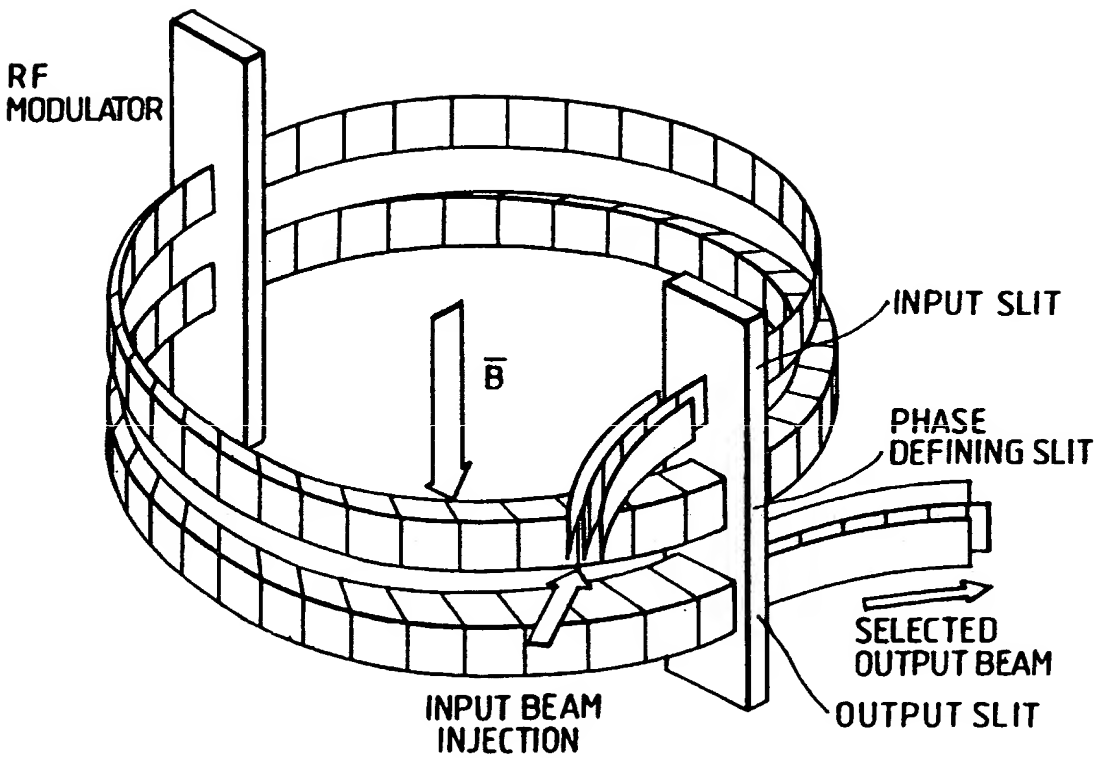
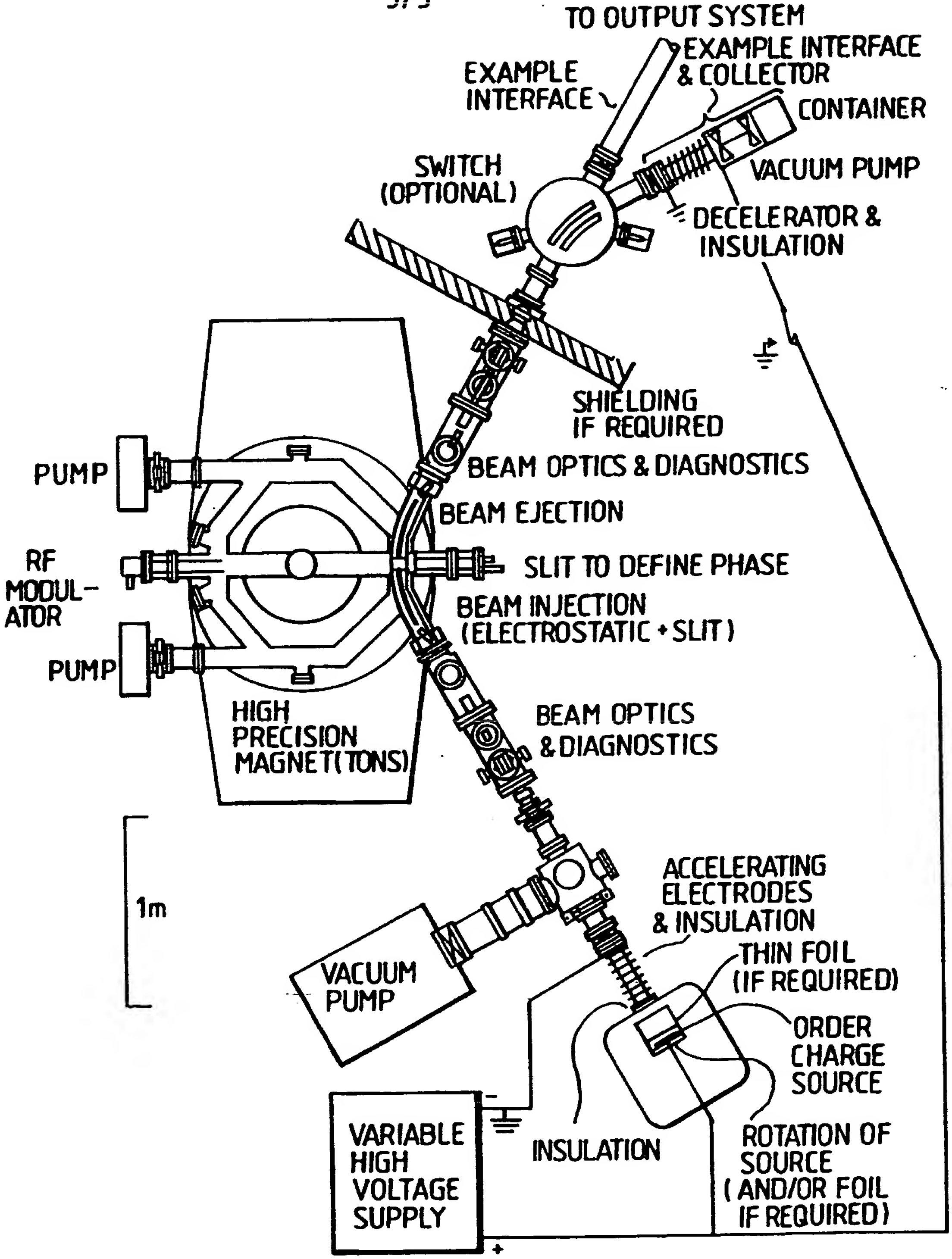
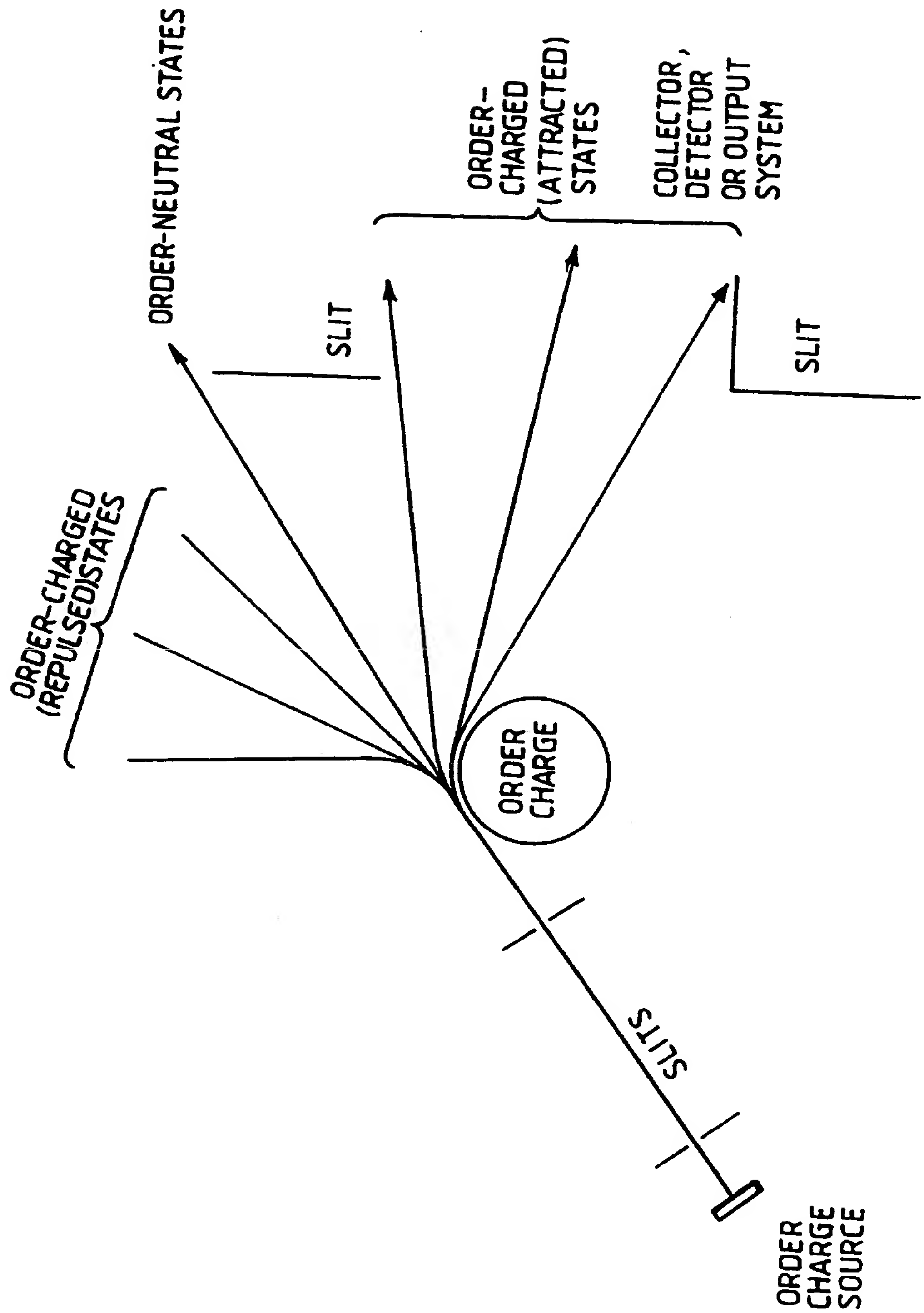

RF
MODULATOR
INPUT SLIT
$\overline{B}$
PHASE
DEFINING SLIT
SELECTED
OUTPUT BEAM
INPUT BEAM
INJECTION
OUTPUT SLIT

Fig.3.



TO OUTPUT SYSTEM
EXAMPLE INTERFACE
EXAMPLE INTERFACE & COLLECTOR
CONTAINER
SWITCH (OPTIONAL)
VACUUM PUMP
DECELERATOR & INSULATION
SHIELDING IF REQUIRED
PUMP
BEAM OPTICS & DIAGNOSTICS
BEAM EJECTION
RF MODUL-ATOR
SLIT TO DEFINE PHASE
BEAM INJECTION (ELECTROSTATIC + SLIT)
PUMP
HIGH PRECISION MAGNET(TONS)
BEAM OPTICS & DIAGNOSTICS
1m
ACCELERATING ELECTRODES & INSULATION
VACUUM PUMP
THIN FOIL (IF REQUIRED)
ORDER CHARGE SOURCE
VARIABLE HIGH VOLTAGE SUPPLY
INSULATION
ROTATION OF SOURCE (AND/OR FOIL IF REQUIRED)

Fig.4.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ORDER-CHARGED (ATTRACTED) STATES
COLLECTOR, DETECTOR OR OUTPUT SYSTEM
SLIT
SLIT
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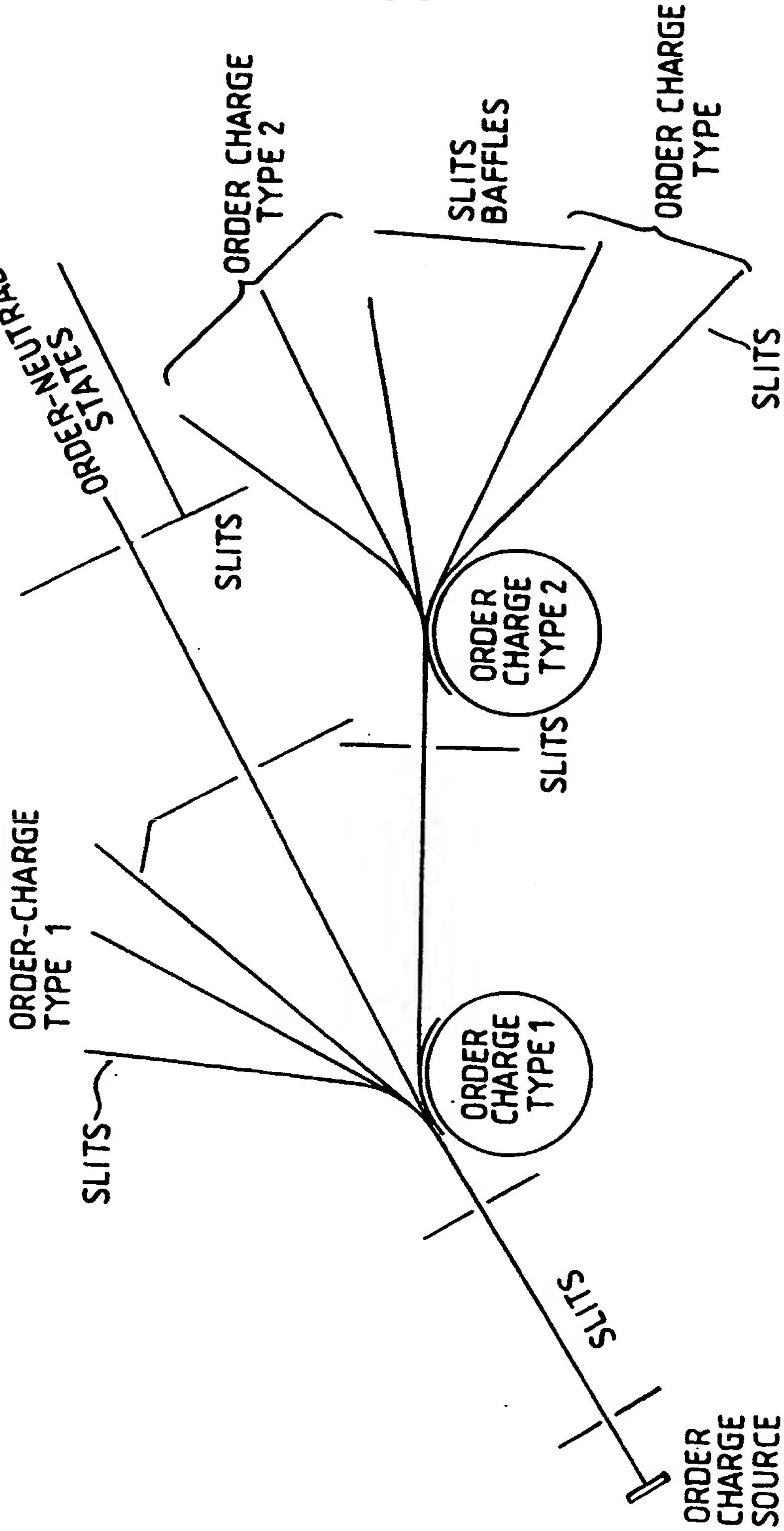
SLITS
ORDER CHARGE SOURCE

Fig.5.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SLITS BAFFLES
ORDER CHARGE TYPE
ORDER-NEUTRAL STATES
SLITS
SLITS
ORDER CHARGE TYPE 2
SLITS
ORDER-CHARGE TYPE 1
ORDER CHARGE TYPE 1
SLITS
SLITS
ORDER CHARGE SOURCE

Fig.6.

INTERNATIONAL SEARCH REPORT

Inte ..ional Application No
PCT/GB 98/02562

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G21K1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G21K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 559 202 A (EBARA CORP) 8 September 1993 see abstract	1,18
A	US 3 790 440 A (KESHISHIAN V) 5 February 1974 see column 1, line 66 - column 2, line 36	2
A	US 4 875 945 A (PENZHORN RALF-DIETER ET AL) 24 October 1989 see abstract	3
A	PATENT ABSTRACTS OF JAPAN vol. 015, no. 054 (E-1031), 8 February 1991 & JP 02 284398 A (NEC CORP), 21 November 1990 see abstract	4,6

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 November 1998	26/11/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Capostagno, E

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/02562

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 096, no. 011, 29 November 1996 & JP 08 188459 A (KUMAGAI TEKKO:KK;AKOU:KK), 23 July 1996 see abstract	5
A	WO 87 07762 A (LAZARUS STEVEN) 17 December 1987 see page 2, last paragraph - page 3, paragraph 1	8
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 139 (E-1519), 8 March 1994 & JP 05 325854 A (SUMITOMO ELECTRIC IND LTD), 10 December 1993 see abstract	33
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 164 (E-745), 19 April 1989 & JP 63 318063 A (JEOL LTD), 26 December 1988 see abstract	34
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 331 (P-755), 7 September 1988 & JP 63 094140 A (HITACHI LTD), 25 April 1988 see abstract	38

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 98/02562

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		US 4855596 A	08-08-1989

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/02562

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IPC 6 G21K1/00

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G21K

PTO/PCT Rec'd 25 FEB 2000

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"&" document member of the same patent family

Date of the actual completion of theinternational search	Date of mailing of the international search report
20 November 1998	26/11/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Capostagno, E

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/02562

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 331 (P-755), 7 September 1988 & JP 63 094140 A (HITACHI LTD), 25 April 1988 see abstract -----	38

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 98/02562

Patent document cited in search report	Publication date	Patent family member(s)	Publication dat
EP 0559202 A	08-09-1993	JP 5251039 A	28-09-1993
		AT 148263 T	15-02-1997
		DE 69307557 D	06-03-1997
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US 3790440 A	05-02-1974	DE 1564409 A	17-07-1969
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		US 4855596 A	08-08-1989

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P57490P	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 98/02562	International filing date *(day/month/year)* 26/08/1998	(Earliest) Priority Date *(day/month/year)* 26/08/1997
Applicant ELLIS, Richard, John		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] **Certain claims were found unsearchable** (see Box I).

2. [ ] **Unity of invention is lacking** (see Box II).

3. [ ] The international application contains disclosure of a **nucleotide and/or amino acid sequence listing** and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application.
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] Transcribed by this Authority

4. With regard to the **title**,
   - [X] the text is approved as submitted by the applicant
   - [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   - [X] the text is approved as submitted by the applicant
   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this International Search Report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is:

   Figure No. ______
   - [ ] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [X] None of the figures.

PA. _NT COOPERATION TREAT

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 27 May 1999 (27.05.99)	
International application No. PCT/GB98/02562	**Applicant's or agent's file reference** P57490P
International filing date (day/month/year) 26 August 1998 (26.08.98)	**Priority date** (day/month/year) 26 August 1997 (26.08.97)
Applicant ELLIS, Richard, John	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

24 March 1999 (24.03.99)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was [ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer C. Carrié Telephone No.: (41-22) 338.83.38

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PATENT COOPERATION TREATY

NATIONAL PRELIMINARY EXAMINING AUTHORITY

RICE, V.
FRY HEATH & SPENCE
The Old College
53 High Street
Horley, Surrey RH6 7BN
GRANDE BRETAGNE

RECEIVED
20 OCT 1999

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NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

	Date of mailing (*day/month/year*) 18. 10. 99
Applicant's or agent's file reference P57490P	**IMPORTANT NOTIFICATION**

International application No.	International filing date (*day/month/year*)	Priority date (*day/month/year*)
PCT/GB98/02562	26/08/1998	26/08/1997
Applicant: ELLIS, Richard, John		

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Magliano, D Tel.+49 89 2399-2245

PATENT COOPERATION TREATY

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PTO/PCT Rec'd 25 FEB 2000

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P57490P		
International application No. PCT/GB98/02562	International filing date (day/month/year) 26/08/1998	Priority date (day/month/year) 26/08/1997
International Patent Classification (IPC) or national classification and IPC G21K1/00		
Applicant ELLIS, Richard, John		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 13 sheets.

3. This report contains indications relating to the following items:

   I ☒ Basis of the report
   II ☐ Priority
   III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   IV ☐ Lack of unity of invention
   V ☐ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   VI ☐ Certain documents cited
   VII ☒ Certain defects in the international application
   VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
24/03/1999	18.10.99

Name and mailing address of the international preliminary examining authority:	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Frank, V Telephone No. +49 89 2399 2726

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB98/02562

I. Basis of the r port

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-12	as originally filed

Claims, No.:

1-75	as received on	12/07/1999	with letter of	09/07/1999

Drawings, sheets:

1/5-5/5	as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-75.

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 1-75 are so unclear that no meaningful opinion could be formed (*specify*):

see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The expressions "order charge", "source of order charge", "order charge selector/separator", "order charge output system", "order charge collector" and "order charge type separation" used in claim 1 have no clear defined meaning. In consequence, a skilled person is unable to determine the device features associated to said expressions and to determine if a given apparatus falls or not within the scope of the claims.

   An evaluation of the novelty, inventiveness and industrial applicability of the claimed subject-matter is not possible, as the precise scope of the claims cannot be determined for the above mentioned reasons.

2. The experimental evidence presented by the applicant to support his theory of the Ordering Force consists of five preprints (Evidence for the Unified Field I to V) which have not been accepted for publication in a recognized journal of physics; i.e. they have not passed the generally accepted peer review of scientists working in the field.

   The examiner is, for this reason, unable to assess the scientific relevance of the contents of these preprints.

3. High resolution ion mass spectrometers are well known in the prior art (see e.g. the documents cited in the search report). A device in which the "order charge selector/separator acts in other ways than by the ordering force, such as a high resolution mass spectrometer ..." as claimed in claim 2 seems to be not new over said prior art.

Re Item VII

Certain defects in the international application

1. Several claims comprise text between parentheses to indicate the plural form of

some embodiments or some further clarifications (cf. claims 9, 11, 24, 28, 37, 40, 44, 46, 51, 57, 59, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73). The use of parentheses should, however, be limited to reference signs (see below).

2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Re Item VIII

Certain observations on the international application

1. The expression "or combinations thereof" when referring to the dependence of the claims used in claims 5-75 makes the scope of said claims unclear (Article 6 PCT), since it is unspecified how said subject-matter may be combined.

2. The use of the expressions "with or without", "may or may not" and "is/are or is/are not" and the use of a multiplicity of and/or's, renders the scope of the claims unclear (Article 6 PCT).

3. The expression "some kind of" used in the claims is undefined and thus unclear (Article 6 PCT).

PTO/PCT Rec'd 25 FEB 2000

CLAIMS

1. An order charge separation apparatus comprising a source, with or without suitable modifications to enhance the flux and/or concentration of order charge, with/or without ionization equipment, with/or without suitable interface, an order-charge separator if required, with/or without suitable output interface, and/or with a suitable output system, and/or a suitable collector if required, single, series, multiples and/or cascade arrangements of similar and/or different devices, separating, and/or collecting, and/or output devices, all with suitable vacuum systems, optics, and/or slits and/or baffles, and/or supporting equipment.

2. An order charge separation apparatus as claimed in 1, wherein the source is a source of ionizing radiation, such as an alpha emitter, which carries the order charge on at least some of the particles of radiation.

3. An order charge separation apparatus as claimed in 1, wherein the source is some form of matter, some or all of which carries the order charge such as helium from a reactor, and/or order-charged states which have previously been through some stage or stages of separation, and/or purification, and/or concentration, which may or may not be ionized electrically.

4. An order charge separation apparatus as claimed in 1, wherein the source is some kind of radiation device, such as a nuclear reactor or accelerator, in which the device produces order-charged matter either continuously or in bursts, or some combination, either partially or totally ionized or non-ionized, which then may or may not have to be separated or concentrated, or otherwise processed either continuously or in batches, so as to produce a supply of order-charged matter which can then be fed to or supplied to the source of the order-charge separation apparatus as its source of order-charged matter.

5. An order charge separation apparatus as claimed in 1, wherein the source is some kind of radioactive halo and/or rock and/or crystal and/or material there from, and/or other material substance which contains order charge, which may/or may not have to be first processed to carry out some kind of preliminary order-charge concentration either on the basis of the region of origin of the matter, and/or the particular properties of the matter which is known to carry the order charge, and/or on some other basis.

6. An order charge separation apparatus as claimed in 1, wherein the source is some kind of particle accelerator, nuclear or heavy ion accelerator and/or storage ring and/or colliding beam machine, which by processes of suitable interactions causes nuclei to fragment into fragments, some or all of which are order-charged. These interactions could be brought about by a beam of nuclei being made to collide with target nuclei, or by a beam or source of elementary particles or other matter or radiation being made to collide with target nuclei or vice versa, so that some order-charged fragments or radiation are produced. Heavier nuclei may produce more order-charged fragments, but any nuclei which produce some order-charged fragments will do. This may or may not include further apparatus. For example, the fragments produced may or may not be mass and/or momentum and/or direction selected, and /or cooled, and/or decelerated, and/or accelerated, and/or focused into a beam of fragments, and/or ionized.

7. An order charge separation apparatus as claimed in 1, wherein the source consists of free order charge which has subsequently been attached to matter. Orderons are order-charged or at least order-antiorder charged, and for example come from the sun, so that exposure of matter to sunlight in some way will result in it being permeated with some form of order charge. If the matter was originally order-neutral, then it will become filled with orderons carrying the order charge, but not actually directly attached to the nuclei, although they could be attached indirectly, for example by order van der Waals forces. Such matter exposed to orderons might or would then be a source of order charge, albeit after further processing to put the matter in a state suitable for separation and/or collection.

8. An order charge separation apparatus as claimed in 1 and 2, wherein the radiation has been passed through the input interface if necessary, and been separated, collected and/or concentrated in someway to concentrate or enhance the flux, and/or wherein the radiation has been ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated or degraded, and/or accelerated, and/or some combination of these.

9. An order charge separation apparatus as claimed in 1 and 3, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

10. An order charge separation apparatus as claimed in 1 and 4, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

11. An order charge separation apparatus as claimed in 1 and 5, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

12. An order charge separation apparatus as claimed in 1 and 6, wherein the fragments are passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

13. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and/or 12, or combination thereof, wherein there is one or more

sources of order charge which may be used in various ways including one at a time, sequentially, alternatively, and/or simultaneously.

14. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and/or 13, or combination thereof, wherein there is switch-yard to facilitate switching from one source to another, if required.

15. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and/or 14, or combination thereof, wherein the partially or completely order-charged matter is suitably prepared for separation and/or collection.

16. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and/or 15, or combination thereof, wherein the partially or completely order-charged matter is introduced into the separator, and/or collector.

17. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and/or 16, or combination thereof, wherein the partially or completely order-charged matter is passed through a separator so as to separate, partially or completely, order-charge from order-neutral states, and/or otherwise concentrate order-charge and/or order-charged states.

18. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein the separator is a mass spectrometer or mass-spectrometer type of apparatus, and/or accelerator-type of mass-spectrometer, and/or accelerator, and/or cyclotron or similar device, and/or storage ring, and/or Penning trap and/or Smith-type spectrometer, or some combination of same, in which combinations of electric and/or magnetic fields and/or time-of-flight, and/or slits, and/or other methods, separate different mass states corresponding to different order-charge states.

19. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and/or 17, or combination thereof, wherein the separator is based upon range, so that a precisely determined amount of matter is used to separate and/or concentrate order-charge and/or order-charged states at the expense of order-neutral states.

20. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and/or 17, or combination thereof, wherein the separator is a combination of range and a mass spectrometer (eg as specified in 19 and 18 respectively), so that partial separation is brought about by range, and then further separation is brought about by using a mass spectrometer, or vice versa, or by some other method. Alternatively, range attenuation may be used as part of the input interface to reduce the energy of the input particles either to those that match the mass spectrometer, or to even lower energies, cool and/or thermalize them, as part of an input interface which subsequently accelerates and/or focuses the order-charged states so as to match their input energy and phase space of the mass spectrometer and maximize the flux through it if so desired.

21. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein the separator is some other type of spectrometer with an electric and/or magnetic field together with some kind of velocity detector/selector and/or time-of-flight device and/or energy loss device, which can separate different mass states.

22. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein the separator is on one or more other types of process which may be mass-sensitive, or may be sensitive to nuclear magnetic moments, or may otherwise be sensitive to order charge directly or indirectly, such as various types of spectrometer, diffraction, resonance processes, kinematic processes, range, diffusion, and even certain chemical reactions, which could be used to separate order-charged matter from order-neutral matter.

23. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein the separator is an order-charge separator where the active element is order-charge itself, either previously separated or otherwise obtained, and/or an order-charge field, so that order-charge states passing through this order-charge spectrometer tend to be deflected by the order-charge and/or order field, whilst order-neutral states are not so deflected and so continue in their normal trajectory. (Such an order-charge separator may be referred to as a secondary separator, although once built it may be used as a primary separator.) Some order-charge will be repulsed by the separator, other charge will be attracted by it. The former is like charge, the latter are the different charges. The former tends to be purer in the sense that it is one charge state, whereas the latter tends to contain two charge states, depending how pure the separator charge and/or field is.

24. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and/or 23, or combination thereof, wherein some kind of restriction(s), limitation(s), cut(s), slit(s) and/or aperture(s), and/or optics, or other type of separation(s), either physically, logically, and/or both, or some combinations of these, is/are introduced to separate and/or concentrate order-charge states from order-neutral states, which could be made at one or more or various places in the system as required.

25. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23 and/or 24, or combination thereof, wherein some kind of fixed, and/or moveable, and/or variable slit(s) and/or aperture(s) and/or barrier(s) is/are used to separate order-charged states from order-neutral states. In particular, if there is a mass spectrometer, the mass, order-charge and/or other type of spectrometer which may or may not be equipped with some kind of entrance aperture, and may or may not be equipped with some kind of exit aperture and/or other apertures positioned in such a way as to separate order-charged states from order-neutral states. The exit slit(s) or aperture(s) may or may

not be positioned at the exit focus, and may or may not be an image of the entrance slit(s) or aperture(s). By adjusting the slit(s), and/or aperture(s), and/or barrier(s), and/or frequency(ies), and/or magnetic field, and/or optics, and/or timing, and/or kinematic limits, and/or any other parameters, qualities, aspects cuts, and/or conditions of the system, it may or may not be optimized for maximum resolution, and it may or may not be optimized for maximum flux or yield through the apparatus, and/or it may or may not be optimized in some other way, or some combination of these.

26. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19 and/or 20, or combination thereof, wherein the thickness of material traversed is sufficient to partially and/or completely separate order-charge from order-neutral states. The range separation may be supplemented by some other method. This technique may be part of the input interface to the subsequent method of separation.

27. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 and/or 26, or combination thereof, wherein some kind active and/or triggered device is engaged to separate one or a small group of order-charged particles and/or states from order-neutral states. Such a device might be a mobile shutter, or a pulsed field, electric or magnetic and/or both, or a kicker magnet, or some other mechanical and/or electronic and/or order-charged device, and/or time-of-flight system, and/or pulse height technique, and/or energy loss system.

28. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26 and/or 27, or combination thereof, wherein selecting upon those states which carry the order charge it might be concentrated in certain circumstances. In particular, order-charged matter may have different energy and/or directional properties at the source, and these could be selected upon to enhance the concentration of order-charged matter. This is particularly the case for order-charged fragments produced in nuclear collisions where some kind of

direction and/or velocity, and/or momentum, and/or particle-type, and/or other selection(s) would enhance the order charge flux and/or composition, and/or purity, but it might also apply to certain radioactive sources. Furthermore, this selection at source which might achieve sufficient purity under certain conditions, but if necessary it is also be combined with a suitable separator.

29. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 and/or 28, or combination thereof, wherein there is some kind of output interface if necessary, and/or output system (eg to act as a source), and/or some kind of collector to collect the order charge.

30. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28 and/or 29, or combination thereof, wherein the output interface, if necessary, and/or output system, and/or the collector is/are some kind of stopping device and/or container, suitably shaped, if necessary, to collect the order charge and/or if necessary minimize the discharge of order charge.

31. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 and/or 30, or combination thereof, wherein the collector is designed to trap and if necessary stop the order-charged matter, and/or order charge, and/or other matter, as it leaves the source and/or separator. The collector can be a container, suitably shaped if necessary, attached to the source and/or separator, or separate from it if necessary, or even a hopper, depending upon the type of material to be collected.

32. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30 and/or 31, or combination thereof, wherein the output of the source and/or separator is in a vacuum or semi-vacuum and is moving, and this output passes through any valves and/or diaphragms and/or apertures

as necessary, into the stopper and/or collector, so that the output is slowed and/or stopped, and then either contained, and/or extracted from the vacuum.

33. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and/or 32, or combination thereof, wherein the stopper is a Faraday cup, and/or metal plate, and/or other material, solid, liquid or gaseous (provided that it does not spoil the vacuum too much, for example it might be in a containing material or materials), which stops and may or may not absorb the order-charged materials. If the stopper absorbs the order-charged materials, then there is a way or ways of extracting the order-charged materials and/or order charge either on-line or off-line, either continuously or in steps. For example, the metal plate could simply be removed after absorbing the order-charged material for a certain time, and the order charge used and/or extracted off-line. Or this could be a stage in the manufacture of the stopping material. Or if there is fluid in the stopper, then this fluid could be extracted and/or circulated either continuously or after a certain amount of time, taking most of the order charge with it for subsequent separation. Or the stopper could be made to re-emit the order charged matter, either continuously or in stages, for example by heating, so that it could then be collected in a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge. Or if the stopper is moveable, either discretely and/or as a continuous strip, then it could be first moved to a separate area in the vacuum chamber which could be partially or even completely protected from the rest of the vacuum system, where the stopper or a portion of the stopper could be made to re-emit the order charged matter, either continuously or in stages, for example by heating, so that it could then be collected in a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge.

34. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32 and/or 33, or combination thereof, wherein the stopper is a decelerating device, which may or may not be suitably shaped electric and/or electromagnetic fields, which slows or otherwise stops the output from the separator, so that it could then be collected in a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge.

35. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33 and/or 34, or combination thereof, wherein the container with the separated and/or purified order charge can be separated from the rest of the apparatus and then taken away for use elsewhere. This can be done in such a way that the source and/or separator can be operated continuously or in a batch mode.

36. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34 and/or 35, or combination thereof, wherein the order charge is deposited, stopped in, or otherwise applied to materials, components, and/or devices, which are subsequently going to be used in that or some other order-charged state. The order charge could be deposited in one region, or it could be applied over an extended region or several regions and/or spots, either by moving the beam of order-charged and/or by moving the material, component, and/or device. This could be as part of their manufacturing process. This could be done in batch mode, or a few at a time. Or it could be done partially or completely continuously, with the materials, components, and/or devices being introduced into the order beam either singly or in groups, either a few at a time or as part of an assembly-line system with more continuous flow, possibly with suitable materials handling devices.

37. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 and/or 36, or combination thereof, wherein alternatively to, or in addition to the collector system, there is some kind of output system. The output system could provide an order-charge source, and/or order-charge beam, and/or be part of an order-charge treatment plant. It could be used to supply order-charge directly to where it is needed, or to be used, and/or it could provide a beam of order charge. In the latter case, the beam could be either internal, or external. For an external beam, a thin window would allow order-charged matter to exit the system as a beam. The range would not be far in air, but this might be sufficient for whatever usage was required. Whatever the output system and/or collector, further optics and/or acceleration and/or deceleration could be part of the output system.

38. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 and/or 37, or combination thereof, wherein there is a detector(s), or detector system, which is/are in or can be placed or inserted in the output (separated) beam, and/or to which that beam can be directed, and/or by some other mechanism. The system is operated in such a way as to separate order-charge states from order-neutral states. (We refer to such separation systems, and sequences of such systems, as "type-0 spectrometers" for convenience of reference.) This would normally require precise measurements of the mass(es) of the order-charge states, for which the detector would be necessary. Once this or these have been obtained, the apparatus can then be tuned to select that particular state that carries the required order charge. The detector would facilitate this tuning. With careful design, the apparatus can be arranged and/or adjusted so as to select the required order-charge state as cleanly as possible and/or to maximise the through-put and hence the efficiency. The detector would also facilitate these adjustments. It could even be used to monitor performance, for example by switching it in and out of the beam as required.

39. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37 and/or 38, or combination thereof, wherein one or more of these processes can be applied sequentially and/or in combinations.

40. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38 and/or 39, or combination thereof, wherein order charge having been separated it is subsequently used to generate suitable order fields which then subsequently separate further the order-charged states from the order-neutral states, and/or from each other (ie to separate the three order charges). This could be a type of order spectrometer, for example in which order charge and/or order fields is/are the active element(s). Previously separated order charge could be suitably shaped and used either as the deflecting mechanism in an order charge spectrometer, or it could be combined with suitably shaped electric and magnetic fields to improve the optics and/or separating efficiency and/or flux and/or yields. Such an order spectrometer would have a suitable source(s), suitable input interface(s) if required, suitable output interface(s) if required, suitable output system(s) and/or suitable collector(s), and/or suitable optics, slits baffles, selecting systems, vacua and supporting equipment.

41. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39 and/or 40, or combination thereof, wherein the separation process is brought about by previously separated order charge, or by an order field, which is then used to separate order-charge from order-neutral states, and/or to further separate and/or purify order charge, for example by repeated passes, and/or repeatedly upgrading the deflecting order charge in the spectrometer, and/or by means of a series of spectrometers and/or devices. When order charge passes near to order charge, the two charges will be attracted or repelled from each other according as to whether they are different or like charges. Because

there are three types of order charge, depending upon the composition of the deflecting order-charge in the spectrometer, one sort of charge will be repelled (the like charge) and the other two charges (the different charges) will be attracted. As a result, the repelled charge will tend to be the purer order-charge state. Order charge that has been separated from order-neutral states, will not initially be in one of the three order-charge states, but will tend to be a random collection of the three order charges. As a result, the numbers of different types of order charge will vary and one type will be dominant, however slightly. (Furthermore, statistical fluctuations will tend to be larger in small samples rather than large samples. So there is a trade-off between using smaller samples of charge, where the dominant charge-type is more clearly defined but the force exerted on the order-charges to be separated is less, and larger samples of order-charge where the dominant charge-type is less well-defined but the force exerted on charges to be separated is greater. The system has to be designed and tuned so that one starts to separate, even if only statistically, on a particular order-charge type.) If the three types of order charge are passed by an order-charge spectrometer which uses this mixed order charge as its active separating element, then the repulsed charge, especially the more strongly repulsed charge, will be the like charge of the dominant charge. Therefore by selecting on the repulsed charged, it is possible to create a sample of a particular type of order charge (say type 1) or at least a more pure sample than was in the incident beam.

42. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40 and/or 41, or combination thereof, wherein the repulsed order charge is used to effect further separation, either by being collected and formed into a pole for the primary order-charge spectrometer that has just selected it (as in 41) and then used to replace that pole (and so form its active element), and/or is used to form the active element(s) of another and/or separate order-charge spectrometer(s), or in some other way.

43. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41 and/or 42, or combination thereof, wherein the repulsed order charge is used repeatedly to form a new pole (ie active element) of primary order-charge separator, and/or used to form poles of secondary, tertiary and/or cascades of subsequent order-charge separators, so that the repulsed order charge is passed through the system, and the repulsed order charge is selected at each stage, and then either used to form the active element of the next (and/or repeated) stage and/or then passed through that subsequent stage and the repulsed order-charge again selected, so that ultimately a pure sample of a particular type (say type-1) of order charge is obtained. (We refer to such separation systems, and sequences of such systems, as "type-1 spectrometers" for convenience of reference.)

44. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42 and/or 43, or combination thereof, wherein the purified order charge (say type 1) is used to form the active element of an order-charge spectrometer, which for convenience we refer to as a "pure type-1 spectrometer". This device can then be used to separate type 1 charge, which is repulsed, from types 2 and 3 charges which are attracted. A sample of types two and three charges are selected and used as the active element of an order charge spectrometer, and types two and three order can start to be separated by a process of amplifying a statistical fluctuation as the type-1 charge was separated. The repulsed charge is selected and then use to form the pole of such a type-2/3 spectrometer, so that further separation of type 2 charge from type 3 can be effected. This could then take place in repeated sequences, or series or cascades of such order charge spectrometers, similar to the way type 1 charge was separated. (We refer to such separation systems, and sequences of such systems, as "type-2/3 spectrometers" for convenience of reference.) In this way, pure type-2 (say) order charge can be separated.

45. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43 and/or 44, or combination thereof, wherein the purified order charge (say type 2) is used to form the active element of an order-charge spectrometer, which we refer to as a "pure type-2 spectrometer". A pure type-2 spectrometer can then be used to separate type-2 charge (the repelled fraction) from type-3 charge (the attracted fraction).

46. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44 and/or 45, or combination thereof, wherein the purified order charge (type 3) is used to form the active element of an order-charge spectrometer, which we refer to as a "type-3 spectrometer". A type-3 spectrometer can then be used to separate type-3 charge (the repelled fraction) from any other backgrounds, if it found that the type-3 charge from the pure type-2 spectrometer is not pure enough. Once a pure enough sample of type-3 charge has been produced, it is then possible to construct a "pure type-3 spectrometer".

47. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 and/or 46, or combination thereof, wherein the various different types of spectrometer are combined together to separate the three order-charge types. The simplest arrangement of these is two pure spectrometers for two different charge types (eg type-1 and type-2 or type-3, type-2 and type-3) in either order, which can then be arranged to separate order-charge from order-neutral matter, and to separate the order charge into each of its charge types. For example a pure type-1 spectrometer will repulse order-charge of type-1, allow order-neutral states to pass straight through, and attract order charges of types -2 and -3 into the second spectrometer, which if it is of the type-2 will repulse type-2 order charge and attract type-3 order charge. A

spectrometer of the third type could be added if further separation of the latter attracted fraction is required. A suitable system of optics, and/or slits, and/or baffles, and/or barriers, is/are used in combination or separately to effect the various separations. The system also has a suitable source(s), vacua, interfaces if required, and/or output systems if required, and/or collectors if required, and/or some combination thereof as required.

48. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46 and/or 47, or combination thereof, wherein the various sources, devices, components, systems, spectrometers, collectors and/or outputs are combined together in such ways as produce the order charge states, whether combined or separate, with the purities and/or in the quantities required.

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P57490P		
International application No. PCT/GB98/02562	International filing date *(day/month/year)* 26/08/1998	Priority date *(day/month/year)* 26/08/1997
International Patent Classification (IPC) or national classification and IPC G21K1/00		
Applicant ELLIS, Richard, John		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 13 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☐ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
24/03/1999	18.10.99
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Frank, V Telephone No. +49 89 2399 2726

Form PCT/IPEA/409 (cover sheet) (January 1994)

I. Basis f th r port

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-12	as originally filed			

Claims, No.:

1-75	as received on	12/07/1999	with letter of	09/07/1999

Drawings, sheets:

1/5-5/5	as originally filed			

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-75.

because:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB98/02562

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 1-75 ar so unclear that no meaningful opinion could be formed (*specify*):

see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question wheth r the claims are fully supported by the description, are made:

see separate sheet

Re Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The expressions "order charge", "source of order charge", "order charge selector/separator", "order charge output system", "order charge collector" and "order charge type separation" used in claim 1 have no clear defined meaning. In consequence, a skilled person is unable to determine the device features associated to said expressions and to determine if a given apparatus falls or not within the scope of the claims.

   An evaluation of the novelty, inventiveness and industrial applicability of the claimed subject-matter is not possible, as the precise scope of the claims cannot be determined for the above mentioned reasons.

2. The experimental evidence presented by the applicant to support his theory of the Ordering Force consists of five preprints (Evidence for the Unified Field I to V) which have not been accepted for publication in a recognized journal of physics; i.e. they have not passed the generally accepted peer review of scientists working in the field.

   The examiner is, for this reason, unable to assess the scientific relevance of the contents of these preprints.

3. High resolution ion mass spectrometers are well known in the prior art (see e.g. the documents cited in the search report). A device in which the "order charge selector/separator acts in other ways than by the ordering force, such as a high resolution mass spectrometer ..." as claimed in claim 2 seems to be not new over said prior art.

Re Item VII

Certain defects in the international application

1. Several claims comprise text between parentheses to indicate the plural form of

some embodiments or some further clarifications (cf. claims 9, 11, 24, 28, 37, 40, 44, 46, 51, 57, 59, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73). The use of parentheses should, however, be limited to reference signs (see below).

2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Re Item VIII

Certain observations on the international application

1. The expression "or combinations thereof" when referring to the dependence of the claims used in claims 5-75 makes the scope of said claims unclear (Article 6 PCT), since it is unspecified how said subject-matter may be combined.

2. The use of the expressions "with or without", "may or may not" and "is/are or is/are not" and the use of a multiplicity of and/or's, renders the scope of the claims unclear (Article 6 PCT).

3. The expression "some kind of" used in the claims is undefined and thus unclear (Article 6 PCT).

CLAIMS

1. An order charge separation apparatus comprising a source of order charge, an order charge selector/separator, order charge output system(s) and/or order charge collector(s), and the same being arranged in series, and/or cascades so as to purify the order charge and/or effectuate order-charge type separation.

2. An order charge separation apparatus as claimed in 1, wherein the active element of the order charge selector/separator acts in other ways other than by the ordering force/charge, such as a high resolution mass spectrometer in which the active element is electromagnetic which acts upon the matter carrying the order charge rather than on the order charge itself, and in which the order charge is fed into the apparatus in such a way that the order-charged states can be separated from order neutral states, and in which there is/are output system(s) and/or order charge collectors, so that the order charge can be used directly and/or collected for subsequent use.

3. An order charge separation apparatus as claimed in 1, where the active element of the order charge selector/separator is based upon the ordering force and/or order charge, for example previously separated order charge so as to create an order charge spectrometer, and into which order charge is fed, either from previous separation in a device such as that in claim 2 and/or some other source, and the said order charge is acted upon directly by the ordering force in the active element to initiate the separation of order charge types, for example into like and unlike types, and sequences of such stages, as in claims 1, 2 and 3 here, and/or repeated processing so as to purify the order charge types and/or eventually separate and/or purify all the order charge types.

4. An order charge separation apparatus as claimed in 1, 2 and/or 3, wherein there is/are or is/are not suitable input interface(s), with or without ionization equipment, with or without suitable output interface(s), together with suitable vacuum systems, optics, and/or slits and/or baffles, and/or supporting equipment, and the system(s) is/are tuned and operated so as to separate order charged matter from order-neutral matter and/or to separate and/or to purify one order-charge type from another until one, two or all order charge types have been separated from each other and/or purified.

5. An order charge separation apparatus as claimed in 1, 2, 3 and/or 4, or combination thereof, wherein the source is a source of ionizing radiation, such as an alpha emitter, which carries the order charge on at least some of the particles of radiation.

6. An order charge separation apparatus as claimed in 1, 2, 3 and/or 4, or combination thereof, wherein the source is some form of matter, some or all of which carries the order charge such as helium from a reactor, and/or order-charged states which have previously been through some stage or stages of separation, and/or purification, and/or concentration, which may or may not be ionized electrically.

7. An order charge separation apparatus as claimed in 1, 2, 3 and/or 4, or combination thereof, wherein the source is some kind of radiation device, such as a nuclear reactor

or accelerator, in which the device produces order-charged matter either continuously or in bursts, or some combination, either partially or totally ionized or non-ionized, which then may or may not have to be separated or concentrated, or otherwise processed either continuously or in batches, so as to produce a supply of order-charged matter which can then be fed to or supplied to the source of the order-charge separation apparatus as its source of order-charged matter.

8. An order charge separation apparatus as claimed in 1, 2, 3 and/or 4, or combination thereof, wherein the source is some kind of radioactive halo and/or rock and/or crystal and/or material there from, and/or other material substance which contains order charge, which may/or may not have to be first processed to carry out some kind of preliminary order-charge concentration either on the basis of the region of origin of the matter, and/or the particular properties of the matter which is known to carry the order charge, and/or on some other basis.

9. An order charge separation apparatus as claimed in 1, 2, 3 and/or 4, or combination thereof, wherein the source is some kind of particle accelerator, nuclear or heavy ion accelerator and/or storage ring and/or colliding beam machine, which by processes of suitable interactions (which may be brought about by a beam of nuclei being made to collide with target nuclei [heavier nuclei may produce more order-charged fragments, but any nuclei which produce some order-charged fragments will do], or by a beam or source of elementary particles or other matter or radiation being made to collide with target nuclei or vice versa, so that some order-charged fragments or radiation are produced), causes nuclei to fragment into fragments, some or all of which are order-charged.

10. An order charge separation apparatus as claimed in 1, 2, 3, 4 and 9, or combination thereof, wherein there may be include further apparatus, for example, the fragments produced may or may not be mass and/or momentum and/or direction selected, and /or cooled, and/or decelerated, and/or accelerated, and/or focused into a beam of fragments, and/or ionized.

11. An order charge separation apparatus as claimed in 1, 2, 3 and/or 4, or combination thereof, wherein the source of order charge consists of free order charge which has subsequently been attached to matter (for example, matter which has been exposed to sunlight, even if it was originally order-neutral, can become filled with orderons [which are order-charged or at least order-antiorder charged], and so become permeated with some form of order charge, which said order charge may not be actually directly attached to the nuclei, although these charges could be attached indirectly, for example by order van der Waals forces), so that the said matter which has free order charge attached to it (for example by being exposed to orderons), which may or may not be processed to put it in a state suitable for separation and/or collection, is used as a source of order charge.

12. An order charge separation apparatus as claimed in 1, 2, 3, 4 and 5, or combination thereof, wherein the radiation is passed through an input interface if necessary, and then separated, collected and/or concentrated in someway to concentrate or enhance the flux, and/or wherein the radiation has been ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated or

AMENDED SHEET

degraded, and/or accelerated, and/or some combination of these.

13. An order charge separation apparatus as claimed in 1, 2, 3, 4 and 6, or combination thereof, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

14. An order charge separation apparatus as claimed in 1, 2, 3, 4 and 7, or combination thereof, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

15. An order charge separation apparatus as claimed in 1, 2, 3, 4 and 8, or combination thereof, wherein the order-charged matter is passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

16. An order charge separation apparatus as claimed in 1, 2, 3, 4, 9 and/or 10, or combination thereof, wherein the fragments are passed through an input interface if necessary, and suitably ionized, and/or turned into a beam, and/or focused, and/or concentrated, and/or deflected, and/or decelerated, and/or accelerated, and/or some combination of these.

17. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and/or 16, or combination thereof, wherein there is one or more sources of order charge which may be used in various ways including one at a time, sequentially, alternatively, and/or simultaneously.

18. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and/or 17, or combination thereof, wherein there is switch-yard to facilitate switching from one source to another, if required.

19. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and/or 18, or combination thereof, wherein the partially or completely order-charged matter is suitably prepared for separation and/or collection.

20. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and/or 19, or combination thereof, wherein the partially or completely order-charged matter is introduced into the separator, and/or collector.

21. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 and/or 20, or combination thereof, wherein the partially or completely order-charged matter is passed through a separator so as to separate, partially or completely, order-charge from order-neutral states, and/or otherwise concentrate order-charge and/or order-charged states.

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22. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 and/or 21, or combination thereof, wherein the separator is a mass spectrometer or mass-spectrometer type of apparatus, and/or accelerator-type of mass-spectrometer, and/or accelerator, and/or cyclotron or similar device, and/or storage ring, and/or Penning trap and/or Smith-type spectrometer, or some combination of same, in which combinations of electric and/or magnetic fields and/or time-of-flight, and/or slits, and/or other methods, separate different mass states corresponding to different order-charge states.

23. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 and/or 21, or combination thereof, wherein the separator is based upon range, so that a precisely determined amount of matter is used to separate and/or concentrate order-charge and/or order-charged states at the expense of order-neutral states.

24. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and/or 23, or combination thereof, wherein the separator is a combination of range and a mass spectrometer (eg as specified in 20 and 19 respectively), so that partial separation is brought about by range, and then further separation is brought about by using a mass spectrometer, or vice versa.

25. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and/or 24, or combination thereof, wherein range attenuation is used as part of the input interface to reduce the energy of the input particles either to those that match the mass spectrometer, or to even lower energies, so as to cool and/or thermalize them, as part of an input interface which subsequently accelerates and/or focuses the order-charged states so as to match their input energy and phase space of the mass spectrometer and maximize the flux through it if so desired.

26. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 and/or 21, or combination thereof, wherein the separator is some other type of spectrometer with an electric and/or magnetic field together with some kind of velocity detector/selector and/or time-of-flight device and/or energy loss device, which can separate different mass states.

27. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 and/or 21, or combination thereof, wherein the separator is based on one or more other types of process which may be mass-sensitive, or may be sensitive to nuclear magnetic moments, or may otherwise be sensitive to order charge directly or indirectly, such as various types of spectrometer, diffraction, resonance processes, kinematic processes, range, diffusion, and even certain chemical reactions, which can be used to separate order-charged matter from order-neutral matter.

28. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 and/or 21, or combination thereof, wherein the separator is an order-charge separator where the active element is order-charge itself, either previously separated or otherwise obtained, and/or an order-charge field, so

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that order-charge states passing through this order-charge spectrometer (which may be referred to as a secondary separator, although once built it may be used as a primary separator) tend to be deflected by the order-charge and/or order field (some order-charge [like charge] will be repulsed by the separator, other charge [different charges] will be attracted by it, and when there are more than two charge states, the former will tend to be purer than the latter because the former will tend to be a single charge state, depending on how pure the separator charge and/or field is, and the latter will include all the different charges which are deflected towards the active element), whilst order-neutral states are not so deflected and so continue in their normal trajectory.

29. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 and/or 28, or combination thereof, wherein some kind of restriction(s), limitation(s), cut(s), slit(s) and/or aperture(s), and/or optics, or other type of separation(s), either physically, logically, and/or both, or some combinations of these, is/are introduced to separate and/or concentrate order-charge states from order-neutral states, which could be made at one or more or various places in the system as required.

30. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28 and/or 29, or combination thereof, wherein some kind of fixed, and/or moveable, and/or variable slit(s) and/or aperture(s) and/or barrier(s) is/are used to separate order-charged states from order-neutral states.

31. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 and/or 30, or combination thereof, wherein some kind of fixed, and/or moveable, and/or variable slit(s) and/or aperture(s) and/or barrier(s) is/are used with a mass spectrometer, order-charge and/or other type of spectrometer, which may or may not be equipped with some kind of entrance aperture, and which may or may not be equipped with some kind of exit aperture and/or other apertures, and which said exit slit(s) or aperture(s) may or may not be positioned at the exit focus and may or may not be an image of the entrance slit(s) or aperture(s), to separate order-charged states from order-neutral states, for example by positioning them in a suitable way to achieve this.

32. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30 and/or 31, or combination thereof, wherein the slit(s), and/or aperture(s), and/or barrier(s), and/or frequency(ies), and/or magnetic field, and/or optics, and/or timing, and/or kinematic limits, and/or any other parameters, qualities, aspects cuts, and/or conditions of the system, is/are adjusted in such a way so that the system may or may not be optimized for maximum resolution, and it may or may not be optimized for maximum flux or yield through the apparatus, and/or it may or may not be optimized in some other way, or some combination of these.

33. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24 and/or 25, or combination thereof, wherein the thickness of material traversed is sufficient to partially and/or completely separate order-charge from order-neutral states.

34. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25 and/or 33, or combination thereof, wherein range separation is supplemented by some other method of order-charge separation, in particular range separation is used as part of the input interface to the subsequent method of order-charge separation.

35. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30, 31, 32, 33 and/or 34, or combination thereof, wherein some kind of active and/or triggered device, which might be a mobile shutter, or a pulsed field, electric or magnetic and/or both, or a kicker magnet, or some other mechanical and/or electronic and/or order-charged device, and/or time-of-flight system, and/or pulse height technique, and/or energy loss system, is engaged to separate one or a small group of order-charged particles and/or states from order-neutral states.

36. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34 and/or 35, or combination thereof, wherein order charge is concentrated by selecting upon those states which carry the order charge.

37. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 and/or 36, or combination thereof, wherein order-charged matter, which has different energy and/or directional properties (from those of order neutral matter) at the source, is selected upon (by selecting the said different energy and/or directional properties) to enhance the concentration of order-charged matter.

38. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 and/or 37, or combination thereof, wherein order-charged fragments from a radioactive source or produced in nuclear collisions which have some kind of direction and/or velocity, and/or momentum, and/or particle-type differences, are selected upon to enhance the order charge flux and/or composition, and/or purity,

39. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37 and/or 38, or combination thereof, wherein selection at source achieves sufficient purity that it is not necessary to combine it with a suitable order-charge separator.

40. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38 and/or 39, or combination thereof, wherein there is some kind of output interface if necessary, and/or output system (eg to act as a source), and/or some kind of collector to collect the order charge.

41. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39 and/or 40, or combination thereof, wherein the output interface, if necessary, and/or output system, and/or the collector is/are some kind of stopping device and/or container, suitably shaped, if necessary, to collect the order charge and/or if necessary minimize the discharge of order charge.

42. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40 and/or 41, or combination thereof, wherein the collector, which can be a container, suitably shaped if necessary, or hopper, attached to the source and/or separator, or separate from it if necessary, depending upon the type of material to be collected, is designed to trap and if necessary stop the order-charged matter, and/or order charge, and/or other matter, as it leaves the source and/or separator.

43. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41 and/or 42, or combination thereof, wherein the output of the source and/or separator is in a vacuum or semi-vacuum and is moving, and this output passes through any valves and/or diaphragms and/or apertures as necessary, into the stopper and/or collector, so that the output is slowed and/or stopped, and then either contained, and/or extracted from the vacuum.

44. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42 and/or 43, or combination thereof, wherein the stopper is a Faraday cup, and/or metal plate, and/or other material, solid, liquid or gaseous (provided that it does not spoil the vacuum too much, for example it might be in a containing material or materials), which stops and may or may not absorb the order-charged materials.

45. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43 and/or 44, or combination thereof, wherein the stopper absorbs the order-charged materials, and there is a way or ways of extracting the order-charged materials and/or order charge either on-line or off-line, either continuously or in steps.

46. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44 and/or 45, or combination thereof, wherein the stopper is a metal plate or other material which is removed after absorbing the order-charged material for a certain time, and either the order charge is used and/or extracted off-line, or this is a stage in the manufacture of the stopping material (eg as a component for another machine or even another machine which requires order charge).

47. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 and/or 46, or combination thereof, wherein the stopper consists of or contains fluid in the stopper, and this fluid is extracted and/or circulated either continuously or after a certain amount of time, taking most of the order charge with it for subsequent separation.

48. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46 and/or 47, or combination thereof, wherein the stopper is made to re-emit the order charged matter, either continuously or in stages, for example by heating, so that it can then be collected in

a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge.

49. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47 and/or 48, or combination thereof, wherein the stopper is moveable, either discretely and/or as a continuous strip, and it is first moved to a separate area in the vacuum chamber which could be partially or even completely protected from the rest of the vacuum system, where the stopper or a portion of the stopper is made to re-emit the order charged matter, either continuously or in stages, for example by heating, so that it is collected in a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge.

50. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48 and/or 49, or combination thereof, wherein the stopper is a decelerating device, which may or may not be suitably shaped electric and/or electromagnetic fields, which slows or otherwise stops the output from the separator, so that it could then be collected in a surrounding container, and/or extracted from the vacuum by a pump, for example a high velocity of rotation rotary vacuum pump, and then pumped into a suitable container to minimize loss and/or leakage of order charge.

51. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49 and/or 50, or combination thereof, wherein the container with the separated and/or purified order charge is separated (which may be done in such away that the source and/or separator can be operated continuously or in a batch mode) from the rest of the apparatus and is then taken away for use elsewhere.

52. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 and/or 51, or combination thereof, wherein the order charge is deposited, stopped in, or otherwise applied to materials, components, and/or devices, which are subsequently going to be used in that or some other order-charged state, either to the whole of the item, or to one region, or it is applied over an extended region or several regions and/or spots, either by moving the beam of order-charged and/or by moving the material, component, and/or device, for example as part of their manufacturing process.

53. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 and/or 52, or combination thereof, wherein the order charge is deposited, stopped in, or otherwise applied to materials, components, and/or devices, either in batch mode, or a few at a time, or partially or completely continuously, with the materials, components, and/or devices being introduced into the order beam either singly or in

groups, either a few at a time or as part of an assembly-line system with more continuous flow, for example with suitable materials handling devices.

54. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52 and/or 53, or combination thereof, wherein alternatively to, or in addition to the collector system, there is an output system, for example which provides an order-charge source, and/or order-charge beam, which is either internal or external or both, and which can be used either as a beam of order charge and/or to supply order-charge directly to where it is needed or to be used, and/or the said output system is part of an order-charge treatment plant.

55. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53 and/or 54, or combination thereof, wherein there is an output system in the form of an external beam, and there is a thin window to allow the order-charged matter to exit the system as a beam.

56. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54 and/or 55, or combination thereof, wherein there is an output system and/or collector, with optics and/or acceleration and/or deceleration as necessary to place the order charge where it is required.

57. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55 and/or 56, or combination thereof, wherein there is a detector(s), or detector system, which is/are in or can be placed or inserted in the output (separated) beam, and/or to which that beam can be directed, and/or by some other mechanism, so that matter passing through the system impinges upon the detector/detector system in order to facilitate and make possible the following operations and modes of operation, for example, so that the mass spectrum of this matter can be measured with sufficient resolution (eg to distinguish order-charged from order-neutral states), and/or so that the region(s) where the ordered-charged states occur can be determined, and/or so that the system can be adjusted/tuned, and/or so that the system can be operated to select that particular state that carries the required order charge, and/or so that the system can be run to separate order-charge states from order-neutral states (such separation systems and sequences of such systems, are referred to as "type-0 spectrometers" for convenience), and/or so that the apparatus can be arranged and/or adjusted so as to select the required order-charge state as cleanly as possible and/or to maximise the through-put and hence the efficiency, and/or so that the detector/detector system can be used to monitor performance, for example by switching it in and out of the beam as required.

58. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53,

54. 55. 56 and/or 57, or combination thereof, wherein one or more of these processes can be applied sequentially and/or in combinations.

59. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52,53, 54, 55, 56, 57 and/or 58, or combination thereof, wherein order charge, having been separated, it is subsequently used to generate suitable order fields which then subsequently separate further the order-charged states from the order-neutral states, and/or from each other (ie to separate the N order charges, where N apparently equals three).

60. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58 and/or 59, or combination thereof, wherein order charge and/or order fields is/are the active element(s) in a new type of spectrometer, an "order charge spectrometer" or simply "an order spectrometer", which acts directly upon the order charge itself.

61. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59 and/or 60, or combination thereof, wherein previously separated order charge is suitably shaped and used either as the deflecting mechanism in an order charge spectrometer, or it is combined with suitably shaped electric and magnetic fields to improve the optics and/or separating efficiency and/or flux and/or yields.

62. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60 and/or 61, or combination thereof, wherein an order spectrometer has suitable source(s), suitable input interface(s) if required, suitable output interface(s) if required, suitable output system(s) and/or suitable collector(s), and/or suitable optics, slits baffles, selecting systems, vacua and supporting equipment.

63. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61 and/or 62, or combination thereof, wherein the separation process is brought about by previously separated order charge, or by an order field, which is then used to separate order-charge from order-neutral states, and/or to further separate and/or purify order charge, for example by repeated passes, and/or repeatedly upgrading the deflecting order charge in the spectrometer, and/or by means of a series of spectrometers and/or devices.

64. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62 and/or 63, or combination thereof, wherein order charge passes by previously separated and/or purified order charged, which may or

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may not be suitably shaped, and/or by an order field, and the repelled or repulsed fraction (ie the fraction which is deflected away from the active element) is collected.

65. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63 and/or 64, or combination thereof, wherein the size or quantity of the previously separated order charge in the active element, is chosen so as to arrive at a suitable compromise between the two situations, the first of which is where the quantity of order charge in the active element is small so that statistical fluctuations in the small sample are large, and there is a tendency for one of the (three) types of order charge to predominate, but the actual deflecting force exerted by that dominant charge-type is too small because the overall sample size is too small, and the second situation where the quantity of order charge in the active element is large so that the amounts of the different types of order charge are (statistically) very similar so that there is not really a dominant order-charge type and so there is little or no net order force exerted on the order charge to be separated because the active element is too close to being order neutral, rather the quantity of order-charge in the active element is chosen so as to separate, even if only statistically, on a particular order-charge type, and/or achieve a non-zero, even maximal, separation efficiency for one of the order-charge types in the repelled fraction, and the repelled fraction, especially the more strongly repelled charge, is separated and collected.

66. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64 and/or 65, or combination thereof, wherein the repulsed order charge is used to effect further separation, either by being collected and formed into a pole for the primary order-charge spectrometer that has just selected it (as in 41) and then used to replace that pole (and so form its active element), and/or is used to form the active element(s) of another and/or separate order-charge spectrometer(s), or in some other way.

67. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65 and/or 66, or combination thereof, wherein the repulsed order charge is used repeatedly to form a new pole (ie active element) of a primary order-charge separator, and/or used to form poles of secondary, tertiary and/or cascades of subsequent order-charge separators (we refer to such separation systems, and sequences of such systems, as "type-1 spectrometers" for convenience), so that the repulsed order charge is passed through the system, and the repulsed order charge is selected at each stage, and then either used to form the active element of the next (and/or repeated) stage and/or then passed through that subsequent stage and the repulsed order-charge again selected, so that ultimately a purer sample of a particular type (say type-1) of order charge is obtained.

68. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32,

33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66 and/or 67, or combination thereof, wherein the purified order charge (say type 1) is used to form the active element of an order-charge spectrometer, which for convenience we refer to as a "pure type-1 spectrometer", and of the order-charge types passed through the system, the type 1 charge is repulsed, and the types 2 and 3 are attracted and collected.

69. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67 and/or 68, or combination thereof, wherein the system is an order charge spectrometer as in claims 60, and/or 61 and/or 62, except that the previously separated order charge in these claims is here the type 2 and 3 order charge collected in a pure type-1 spectrometer, as in claim 65, so that type two or three order can start to be separated by a process of amplifying a statistical fluctuation as the type-1 charge was separated (as in claims 60 to 64, but using an active element containing type 2 and/or type 3 order charge(s)), and the repulsed and/or attracted charges is/are selected and collected, so that further separation of type 2 charge from type 3 can be effected.

70. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68 and/or 69, or combination thereof, wherein the separated charge and/or charges is/are used as the active elements of order charge spectrometers, which are arranged in repeated sequences, or series or cascades of such order charge spectrometers, similar to the way type 1 charge was separated (we refer to such separation systems, and sequences of such systems, as "type-2/3 spectrometers" for convenience), so that purer type-2 and/or type-3 order charge(s) can be separated, and one or both of these is/are selected and/or collected separately, and/or used as an output beam.

71. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69 and/or 70, or combination thereof, wherein the purified order charge, for example the collected charge from the system in claims 65 and/or 66 (say type 2), is used to form the active element of an order-charge spectrometer, which we refer to as a "pure type-2 spectrometer" (if type 2 charge is used), and which acts upon type 2 and type 3 order charges, so as to separate type-2 charge (the repelled fraction) from type-3 charge (the attracted fraction), and one or both of these are selected and collected separately.

72. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70 and/or 71, or combination thereof, wherein the purified order charge (type 3) is used to form the active element of an order-charge spectrometer, which we refer to as a "type-3 spectrometer", and which is then used to separate type-3 charge (the repelled fraction) from any other backgrounds, if it is found that the type-3 charge from the pure type-2

spectrometer is not pure enough, and once a pure enough sample of type-3 charge has been produced, it is then used in the device in this claim or in a separate but similar device as the active element to construct a "pure type-3 spectrometer".

73. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71 and/or 72, or combination thereof, wherein the various different types of spectrometer are combined together to separate the (three) order-charge types, for example the simplest arrangement of these (for three charge types) is two pure spectrometers for two different charge types (eg type-1 and type-2, or type-1 and type-3, or type-2 and type-3) in either order, which are arranged to separate order-charge from order-neutral matter, and to separate the order charge into each of its charge types, for example, a pure type-1 spectrometer will repulse order-charge of type-1, allow order-neutral states to pass straight through, and attract order charges of types -2 and -3 into the second spectrometer, which if it is of the type-2 will repulse type-2 order charge and attract type-3 order charge (a spectrometer of the third type could be added if further separation of the latter attracted fraction is required), and the various order-charge types are then selected upon and collected as required.

74. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 67, 68, 69, 70, 71, 72 and/or 73, or combination thereof, wherein the various different types of spectrometer are combined and/or cascaded, and they are fitted with suitable source(s), vacua, interfaces if required, and/or output systems if required, and/or collectors if required, and/or some combination thereof as required, and a suitable system of optics, and/or slits, and/or baffles, and/or barriers, is/are used in combination or separately to effect the various separations, and the different charges are collected as required.

75. An order charge separation apparatus as claimed in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73 and/or 74, or combination thereof, wherein the various sources, devices, components, systems, spectrometers, collectors and/or outputs are combined together in such ways as produce the order charge states, whether combined or separate, with the purities and/or in the quantities required.

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